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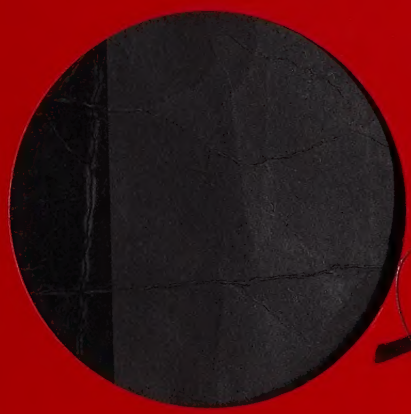

Ballantine

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7050A

ELECTRONIC SIGNAL RECORDER

BALLANTINE LABORATORIES, INC.

P.O. BOX 97
BOONTON, NEW JERSEY 07005 USA
201-335-0900/TWX: 710-987-8380

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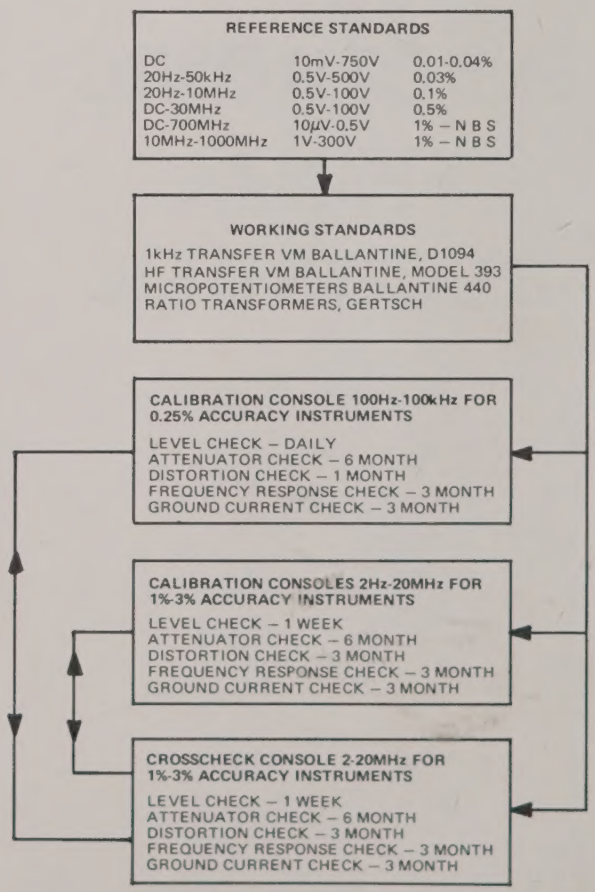
WARRANTY

All Ballantine Laboratories, Inc. products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, except for vacuum tubes and batteries, or, in the case of certain major components listed in the instruction manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

CERTIFICATION

The equipment supplied on your order meets all applicable published Ballantine specifications as determined by thorough testing and inspection. Ballantine's calibration measurements are traceable to the National Bureau of Standards. All instruments used in calibrating Ballantine products are standardized by systematic reference to NBS-traceable standards as described in the validation procedures shown below.


REFERENCE STANDARDS
DC 10mV-750V 0.01-0.04%
20Hz-50kHz 0.5V-500V 0.03%
20Hz-10MHz 0.5V-100V 0.1%
DC-30MHz 0.5V-100V 0.5%
DC-700MHz 10μV-0.5V 1% – N B S
10MHz-1000MHz 1V-300V 1% – N B S
WORKING STANDARDS
1kHz TRANSFER VM BALLANTINE, D1094
HF TRANSFER VM BALLANTINE, MODEL 393
MICROPOTENTIOMETERS BALLANTINE 440
RATIO TRANSFORMERS, GERTSCH
CALIBRATION CONSOLE 100Hz-100kHz FOR 0.25% ACCURACY INSTRUMENTS
LEVEL CHECK – DAILY
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 1 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CALIBRATION CONSOLES 2Hz-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CROSSCHECK CONSOLE 2-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH

Ballantine's Quality Assurance program satisfied the requirements of MIL-Q-9858.

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7050A SPECIFICATIONS

RECORDING:

Frequency Range: DC–100kHz (3dB), usable beyond 200kHz.
Rise Time: 3.6 μsec.
Storage Time Period: 20 mS maximum.
Input Sensitivity 9 ranges in 1, 2.5, 5 sequence
(for an oscilloscope deflection coefficient of 100mV/cm) 4/10/20/40/100 mV/cm
0.2/0.4/1/2V/cm
Input Signal for Full Recording Level: 10 x input sensitivity.
Maximum Input Voltage: 400 volts (DC plus peak AC).
Input Impedance: 1 MΩ ±5%, 36pF ±2pF, compensated on all ranges for use with attenuator probe.
Distortion: < 1.5% at 1kHz.

TRANSFER COMMAND:

AUTOMATIC, from input signal.
EXTERNAL, by control pulse.
MANUAL.
Transfer Trigger Level Range: ±5 x input sensitivity (internal).
Transfer Level Range: ±5 x input sensitivity (internal).
Transfer Slope: positive or negative.
External Transfer Trigger Sensitivity: ⩾ 50 mV, t ⩾ 100 nsec.
Input Impedance, External Transfer Trigger Input: 1 MΩ, 36pF.
Transfer Delay: control for adjusting phasing of 20 ms storage period to record from 16 ms prior to transfer trigger to the 20 ms following the transfer trigger.

PLAYBACK:

Output Level for Full Modulation: ±0.5V (1V p-p).
Signal to Noise Ratio During Full Level Recording: ⩾ 34 dB dynamic range, referenced to full scale.
Signal Output Source Impedance: ⩽ 50 Ω.
Repetition Frequency of Recording: 50 Hz (approx).
Ground Reference: Short-duration reference level pulse recorded on tape at instant of transfer.
Ground Reference Adjustment: permits offsetting recorded signal ±3 x input sensitivity setting, via front-panel control.

PULSE OUTPUTS:

Trigger for Oscilloscope: amplitude, > 13V into open circuit.
Trigger Delay: 4 to 17 ms – continuously adjustable to position signal horizontally on scope.
Blanking for Oscilloscope: amplitude, > 13V into open circuit. Approx. 0.5 ms duration locates transfer period on tape.

PHYSICAL, ENVIRONMENTAL:

Dimensions: Width – 11.25" (300mm)
Height – 4.3 " (110mm)
Depth – 9.5 " (240mm)

Weight: 6 1/2 pounds approx. 2.95 kg approx.
Power Requirements: 115/230V, ±10%, 50 to 60 Hz, 35 Watts.
Ambient Temperature Range: 0°C to +40°C operating.
–30°C to +75°C storage.

ACCESSORIES SUPPLIED:

a) Power Cord	33100000A
b) Tape Loop Kit	70501A
5 Magnetic Tape Loops	
1 Cleaning Loop	
1 Cleaning Stick	
c) 2 Storage Cans	39100021A

ACCESSORIES AVAILABLE:

a) Tape Loop Kit	70501A
5 Magnetic Tape Loops	
1 Cleaning Loop	
1 Cleaning Stick	
b) Tape Storage Box Kit	70502A
10 Shielded Storage Cans	
1 Plastic Storage Box	
c) Probe Kit Attenuator, 6 ft.	10601A
d) Cable, Shielded BNC to BNC, 4 ft.	12249A
e) Termination, 50 ohm feedthru BNC	12630A
f) Adapter, BNC to Dual Binding Post	12622A
g) Oscilloscope, 15 MHz 5 mV Dual Trace	1066A
h) Camera, Polaroid f/4.5 lens	7000A

7050A ELECTRONIC SIGNAL RECORDER

1. GENERAL INFORMATION

The Ballantine 7050A Electronic Signal Recorder records and stores transient signals which are of single occurrence. A static display of the recording may then be displayed on an oscilloscope. In lieu of an oscilloscope, other peripheral instruments can be used. The maximum storage duration is approximately 20 ms for a frequency range of DC to 100 kHz (3 dB). This allows great versatility, including the observation of transients, discharges, voltage breakthroughs, switching durations, etc.

2. DESCRIPTION

Basically, the Ballantine 7050A is a high speed tape recorder with an endless magnetic tape loop. One tape loop rotation takes approximately 20.5 ms, allowing the storage and playback of events having a nominal duration of 20 ms.

During recording, a 750 kHz carrier is frequency modulated by the signal under test. This is recorded continuously while the unit is set to "Record". The signal is erased after each complete revolution of the tape (20.5 ms).

During a non-delayed execution of the recording/playback transfer, the signal recorded during the first 16 ms can be played back. The remaining 4 ms show the signal shape after triggering of the transfer sequence. Transfer from recording to playback may be delayed in a continuously variable fashion to approximately 20 ms. This permits the stored time interval to show the signal after controlled delayed triggering of the transfer circuit.

Recording/playback transfer may be:

a) manually initiated by a front panel pushbutton
b) triggered by the signal under test
c) triggered by an externally supplied pulse

The FM voltage obtained during playback is amplified and demodulated. A pulse derived from the tape and supplied to an output connector of the unit, triggers oscilloscope displays. A trigger pulse delay circuit provides horizontal positioning for the oscilloscope. This permits display of interesting sections of the recording on the oscilloscope even with large horizontal oscilloscope expansion.

The oscilloscope voltage scale can be set independently and irrespective of the selection of the scope time base.

Used tape loops are easy to file and they can be used again and again. Unsuccessful or uninteresting recordings are automatically erased during the next "recording". Shielded tape storage capsules are available to permit storing a library of recorded tapes, Ballantine 70502A.

Figure 1. 7050A Electronic Signal Recorder

3. PRINCIPLES OF OPERATION

3-1. RECORDING

The FM modulator is connected to the input signal when the 7050A is in the "Record" mode. Signals appearing across the input are amplified and are subsequently recorded on the magnetic tape loop.

DC erase is used to saturate the tape and to erase the recording after each revolution of the tape loop. DC erase is suitable for FM recordings since these are modulated into the saturation region of the magnetic tape. The modulator output voltage is fed to the demodulator. The demodulated signal is then fed via a low-pass filter (to suppress the carrier) to the output connector.

3-2. TRANSFER

The transfer from "Record" to "Playback" can be triggered in various forms: internally, externally or manually. Trigger operation for triggering the transfer signal ("trigger point") can select the slope and level of the signal, just as in an oscilloscope. The Variable Transfer Delay is used to delay the transfer signal in relation to the trigger point. The 20 ms storage period can therefore be shifted in relation to the trigger point until the storage window is fully or partly ahead of the trigger point. The remainder of the total 20 ms storage capacity then follows the trigger point.

3-3. PLAYBACK

The signal induced in the playback head is amplified, limited, and fed to the demodulator. The demodulated signal is then fed to the output via a low-pass filter to remove the 750 kHz carrier.

Triggering and blanking of the oscilloscope connected to the 7050A is derived from the tape through a pulse as described below:

As long as the magnetic tape loop carrying a recorded FM signal passes the erase head, no voltage is induced in the erase head coil since the erase head gap width is at least 100 times greater than the longest wave length recorded. As a result no effective magnetic flux is induced in the head when the unmodulated 750 kHz carrier is seen by the head.

The 750 kHz FM carrier is present for approximately 20 ms and a 0.5 ms switching interval takes place during the transfer from record to playback. The 750 kHz carrier is turned off during this 0.5 ms. When the 750 kHz is turned off a transient signal output appears at the erase head. A transient of opposite polarity appears at the erase head when the 750 kHz carrier is switched on. These two signals of opposite polarity are amplified and shaped into a pulse used for z axis intensity modulation on the oscilloscope. This pulse identifies the transfer 0.5 ms switching period which acts as a time reference each revolution of the tape. The ground reference level is carried on the tape during this pulse period.

The intensity modulation pulse could be used to provide external oscilloscope triggering, independent from the content of the recorded signal. It is more advantageous, however, to use the variable output trigger delay Horizontal Positioning to generate a trigger pulse. The oscilloscope is triggered after the delay, whereby, depending on the appearance of this pulse and the oscilloscope time base selected "enlargements" can be shown from the recorded signal.

3.4 GENERAL CAUTION NOTE

115/230 vac and dc supply wires are exposed when the cover is removed. Disconnect the power cord from the power source before removing the covers.

The instrument is provided with a three-conductor power cord which will ground the metalic parts of the shield and cable when connected to a three-connector grounding outlet. If a grounding outlet is not available, an adapter must be used which provides a good grounding connection.

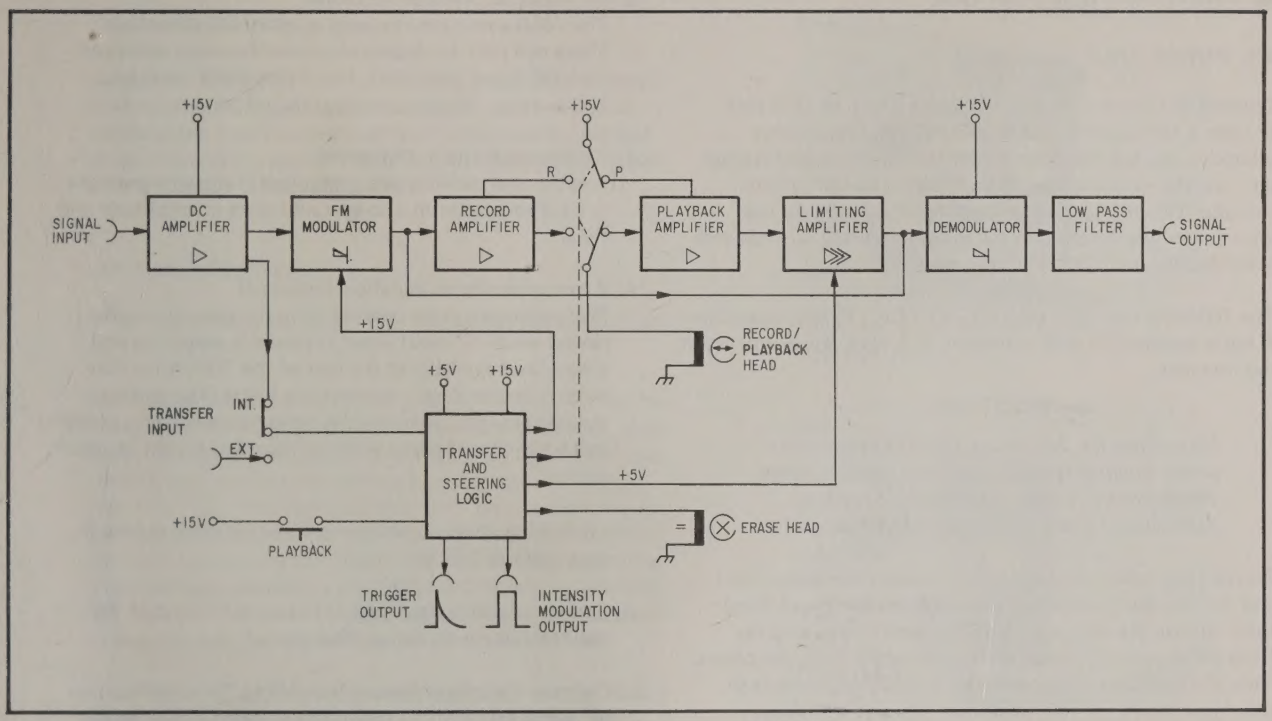


Figure 2. Block Diagram of 7050A

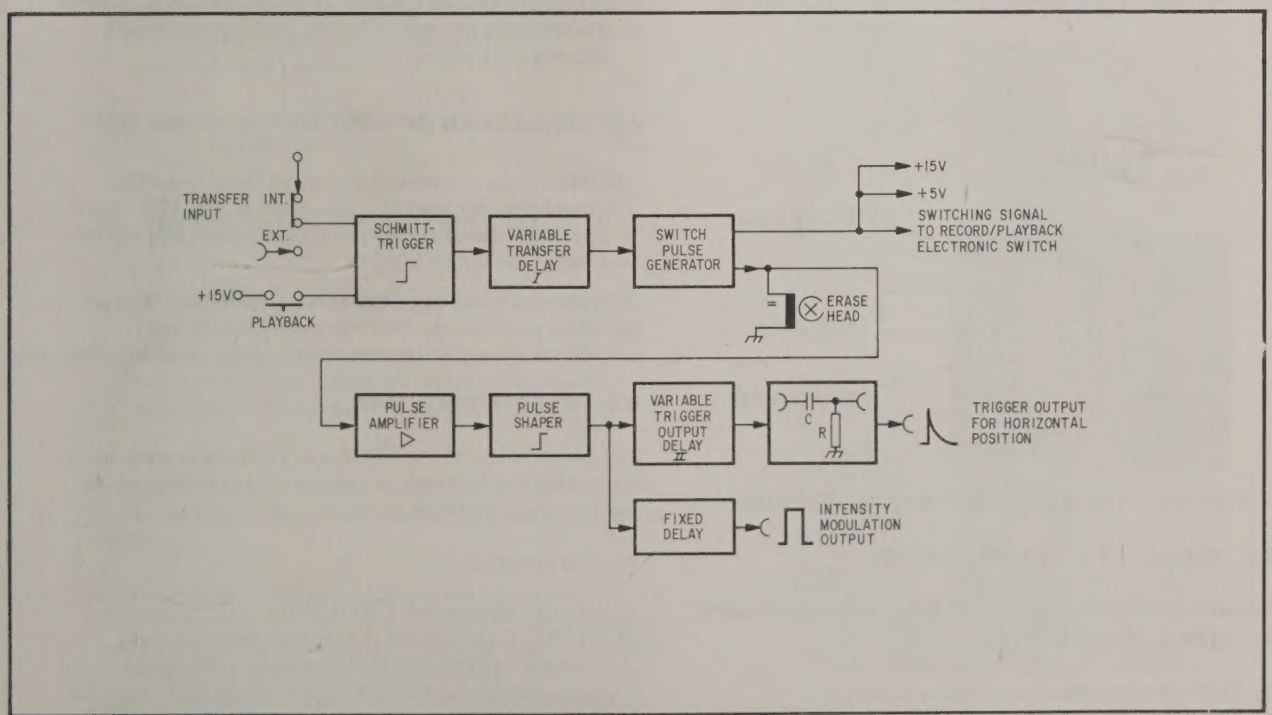


Figure 3. Block Diagram of Trigger and Steering Circuits

4. PREPARATION FOR USE

4-1. POWER LINE

Connect the power line cable (supplied) to jack (27) and provide a voltage of 115/230 V 50-60 Hz. To prevent ground loops, use the same power line for the signal storage unit and the oscilloscope. Turn POWER switch (2) on; indicator (1) will light. The instrument is ready for use after a warming up period of approximately 20 seconds and is fully calibrated within 10 minutes.

The 7050A is normally shipped wired for 115 volt operation. A tag is attached to unit indicating 115 volts power line input requirement.

CAUTION

Do not use the 7050A on 230 volt power lines unless the unit is rewired for this higher voltage. The warranty is void if incorrect power line application causes damage to the instrument.

To reset the power line voltage disconnect the power cord and remove the four corner screws in the rear panel. Carefully remove the enclosure from the unit by holding the front panel and withdrawing the electronics from the covers. Note the insulated standoff with four tie bars which is located just above the fuse post. For 115 volt operation jumper connect tie points 1 and 2 and 3 and 4. For 230 volt operation remove these jumpers and simply connect tie points 2 and 3. Carefully dress all wires and reassemble the electronics into the enclosure by reversing the disassembly procedure.

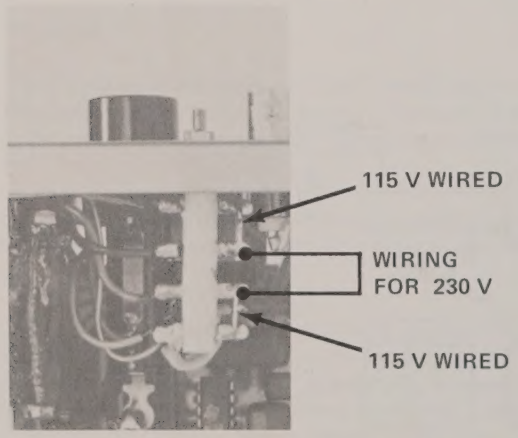


Figure 4. Wiring For 115V or 230V Operation

4-2. CONNECTION OF OSCILLOSCOPE

To use the facilities of the 7050A fully, use an oscilloscope having the following specification:

1. External triggering
   This allows the observation of "enlargements", using delayed trigger pulses derived from the tape and to horisontally position the recorded display on screen.

2. DC Input for Vertical Amplifier
   The 7050A also may be used to store DC potentials. These can only be displayed on oscilloscopes equipped with DC input amplifiers. Input sensitivity must be 100 mV/div. Bandwidth must be $>$ 500 kHz.

3. Calibrated X-and Y-Deflection
   A calibrated oscilloscope is required if stored signals are to be displayed with known calibration in amplitude and time.

4. Z axis intensity modulation (optional)
   The undelayed pulse derived from the tape during the period when no input signal is stored is amplified and shaped and available at the rear of the 7050A for connection to the Z axis input of the scope. This positive pulse is available to blank the period between end of signal and beginning of signal window recorded on the magnetic loop.

The following connections are required between the oscilloscope and the 7050A.

a) Connect signal output jack (11) to the Y-input of the oscilloscope, using connecting cable.

b) Connect the trigger output jack (4) to the external trigger signal input of the oscilloscope, using a connecting cable.

c) Connect the intensity modulation signal output (28) to the oscilloscope Z input. (This connection is optional and generally not required with oscilloscopes having return trace blanking.)

4-3. CONNECTION OF INPUT SIGNAL UNDER TEST

The input signal is connected to signal input jack (15). The input impedance of this connector is 1 MOhm/36 pF to permit the use of conventional oscilloscope test probes such as the Ballantine 10601A.

If an external switching signal is required to transfer from recording to playback, then this signal ($V \geqslant 50$ mV, $t \geqslant 100$ ns) should be connected to transfer input connector (8).

4-4. PERFORMANCE TEST

The performance of the unit should be checked prior to using it for the first time or prior to measurements which require a high degree of accuracy.

Proceed as follows:

a) Set input slide switch (16) to GND.
b) Set MODE slide switch (13) to tape position; press RECORD pushbutton (19) [indicator (18) should light] and set transfer slide switch (6) to EXT. position.
c) Set the oscilloscope to maximum sensitivity and DC input conditions. Adjust the oscilloscope base line to appear across the screen center.

Ground Reference base line:

Adjust the GND REF control until no DC offset potential is shown on the oscilloscope. This is achieved when the oscilloscope base line does not shift when connecting and disconnecting the cable. Focus signal output of the 7050A to the Y input of the oscilloscope.

Amplitude-Alignment:

After completing the GND REF alignment, set oscilloscope to 100 mV/cm.

Connect an AC signal to SIGNAL INPUT BNC (15). Set the input slide switch (16) to AC. If the exact amplitude of this input voltage is unknow, set the MODE slide switch (13) to THRU, and measure the voltage by using the oscilloscope. Set VOLTS/DIV switch (14) to a position in which the input voltage is not greater than 10 times the deflection coefficient selected by the 7050A VOLTS/DIV control. The input voltage, divided by the VOLTS/DIV setting selected, will give the calibrated vertical deflection the oscilloscope (assuming that the oscilloscope is set to 100 mV/cm).

Use AMP CAL (20) panel screw driver adjust on the 7050A to set the oscilloscope deflection to this value.

Example: 250 mV p-p input voltage:
VOLTS/DIV Switch (14) to 40 mV/cm =
250 ÷ 40 = 6.25 cm deflection
VOLTS/DIV Switch (14) to 100 mV/cm =
250 ÷ 100 = 2.5 cm deflection

After carrying out the amplitude-alignment, set MODE slide switch (13) to TAPE position.

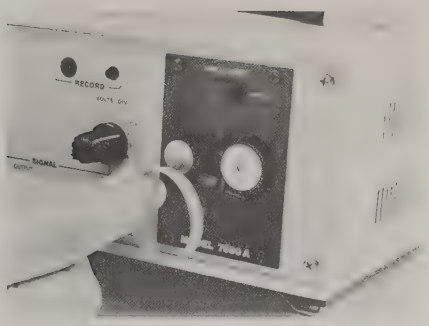
4-5. INSERTING A MAGNETIC TAPE LOOP

NOTE

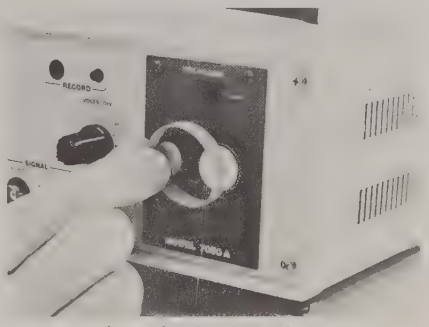
Before fitting a new tape loop or after every 10 hours of operation clean the recording/playback head (see paragraph 6).

Folded, creased or dirty tape loops cause faults and distort the stored signal. When fitting a tape loop always handle it carefully.

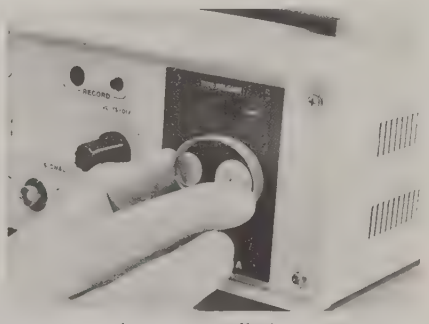
Only insert tape loops when the 7050A is switched off. To simplify insertion, the left-hand tape guide is spring-loaded. If this is pushed to the right then the tape loop can be easily slipped over the tape guide and drive roller. When the tape guide is released, the tape is tensioned and after switching power on it automatically finds its true position.



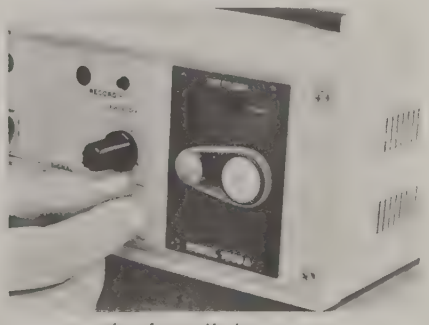
Turn off 7050A before inserting new tape loop . . . . .



. . . . push spring-loaded left-hand tape guide to right . . . .



. . . . tape loop can easily be slipped over drive roller . . . .



. . . . tension is applied to tape when left-hand guide is released.

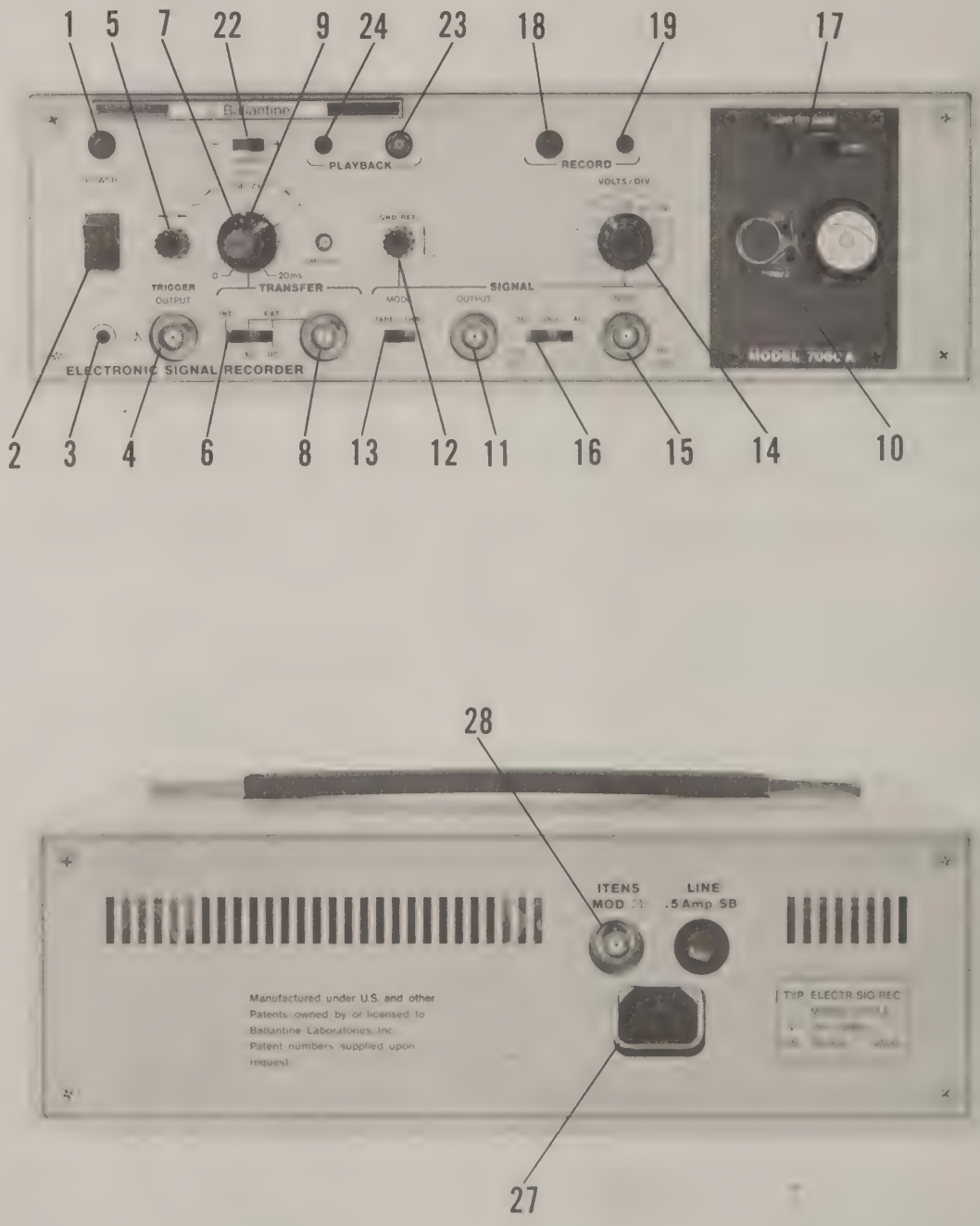


Figure 5. Controls, Connectors, and Indicators

5. OPERATION

5-1. RECORDING

If the voltage level of the signal to be stored is known, set VOLTS/DIV switch (14) accordingly. Peak signal amplitudes should not exceed 10 times the VOLTS/DIV setting.

With an unknown but repetitive input signal, set MODE slide switch (13) to THRU and measure the voltage using the oscilloscope. Afterwards set switch (13) to TAPE and use switch (14) to select the appropriate VOLTS/DIV range.

CAUTION

If the signal exceeds 10 times the value of the deflection coefficient "V/cm" or "mV/cm" set by switch (14), the full recording level is reached. Larger input signals could cause considerable distortion. Input voltages which exceed 100 times the deflection coefficient selected could cause damage to the unit.

Press RECORD pushbutton (19) to select recording. As long as the indicator (18) is on, the signal appearing at the input is recorded continuously and erased after every 20 ms.

5-2. TRANSFER TO PLAYBACK

Transfer to playback can be performed as follows:

a) *internally,* by the signal appearing across the input jack (15).

b) *externally,* via a signal supplied to external transfer BNC connector (8).

c) *manually,* by playback pushbutton (24).

After transfer to playback, record indicator (18) extinguishes and amber playback indicator lamp (23) lights up.

5-3. INTERNAL TRANSFER

The internal transfer operates in accordance with the same principles as used for the amplitude dependent triggering of an oscilloscope. Transfer is possible at any amplitude point of the input signal depending on the setting LEVEL control (9) and the position of SLOPE switch (22). Switch (22) determines the slope at which triggering takes place whereby this occurs in the rising slope in the + position, the falling slope of the input signal in the — position.

The specific amplitude on the slope selected is determined by LEVEL control (9).

Switch (22) to +
Transfer depends on setting of control (9) along the positive (rising) slope.

Switch (22) to —
Transfer depends on setting of control (9) along the negative (falling) slope.

5-4. EXTERNAL TRANSFER

When transfer slide switch (6) is set to EXT, transfer will take place as soon as an external signal of at least 50 mV, (and maximum 200 V peak) and of a duration of at least 100 ns is fed to EXT TRANSFER BNC connector (8). With switch (6) in the AC position, the DC component of the external transfer input signal is blocked.

Selection of the transfer SLOPE and threshold level is as shown for Internal Transfer.

5-5. MANUAL TRANSFER

Pressing pushbutton (24) changes the unit to playback. This button over-rides all other transfer methods.

5-6. TRANSFER DELAY

With DELAY control (7) turned fully counter clockwise, transfer to playback occurs approximately 4 ms after the arrival of the transfer signal (trigger point). This means that the input signal is recorded 16 ms before and 4 ms after the trigger signal.

Clockwise rotation of control (7) increases the transfer delay to a maximum of 20 ms (fully counter clockwise rotation). In this case the only input signal recorded is that which arrives after the transfer is triggered.

The approximate position of the transfer trigger pulse within the storage window can be seen from the scale around the transfer DELAY control.

The total storage time is always 20 ms. Appropriate adjustment of transfer DELAY control (7) continuously shifts the portion of the signal record after the arrival of the transfer trigger from approximately 4 ms to approximately 20 ms.

5-7. PLAYBACK INDICATION

The playback mode of operation is shown by indicator lamp (23).

5-8. ADJUSTMENT OF OSCILLOSCOPE

Set the oscilloscope to 100 mV/cm.

Select a time base whereby the beam covers the screen within 20 ms, showing the full stored event. (An oscilloscope with a horizontal deflection of 10 cm requires the selection of the 2 ms/cm time base scale).

5-9. TRIGGERING OF OSCILLOSCOPE

A trigger output pulse is obtained for each notation of the tape loop when the 7050A is in the "PLAYBACK" mode. This trigger is available at the TRIGGER OUTPUT BNC CONNECTOR (4). This output trigger will trigger the time base of the display oscilloscope thru the oscilloscope external trigger input. Information concerning the correct adjustment and use of the trigger operating controls are shown in the operating instructions of the oscilloscope concerned.

After correct adjustment a static display will appear on the oscilloscope, showing the full signal train recorded. The beginning of the recording, marked by beam blanking, can be shifted with the "Horizontal" control until it appears on the left-hand edge of the display. The DC reference level recorded on the tape may also be used as a convenient left-hand marker.

5-10. DELAYED TRIGGERING

If only part of the signal recorded is of interest and if this is to be magnified, then the oscilloscope time base should be set to an appropriately smaller value (faster deflection speed).

To trigger oscilloscope time base deflection right at the beginning of the section of greater interest, use Horizontal Position control (5) to delay the TRIGGER OUTPUT pulse appearing across connector (4) by up to 17 ms.

5-11. ANALYSIS OF HORIZONTAL SIGNAL TRAIN

Use the time scale selected on the oscilloscope to analyze recorded signals being displayed. Use the 7050A Horizontal Position control to select the time of triggering and use the scope Time/cm and magnified controls to expand the display to observe the point of interest. Magnification beyond 1000 to one are easily possible before tape jitter obscures the display.

5-12. ANALYSIS OF VERTICAL SIGNAL TRAIN

Set the oscilloscope vertical amplifier to 100 mV/cm. Then use the 7050A VOLTS/DIV Control (14) to analyze the input signal. The paximum signal output level of the 7050A is ±500 mV (1 V.p-p).

Setting the oscilloscope to 100 mV/cm (or 100 mV/div) is valid for scopes having 10 cm (div) of vertical display. For 8 cm cathode ray tube displays 20% of the undistorted output from the 7050A will be lost. Appropriate scale factors may be applied by the scope vertical input attenuator and vernier controls to obtain one volt full scale display. A 10 div graticule should be used.

5 cm (div) of graticule can always be used on scopes not having 10 cm (div) of vertical graticule. The scope can then be set to 200 mV/cm (div) and the operator must multiply the 7050A VOLTS/DIV Control (14) by 2.

A reference level of approximately 0.15 ms duration is inserted at the end of each recording for control purposes to allow an exact zero setting of the 7050A on playback, using GND REF control (12).

5-13. TAPE REPLACEMENT

If it is necessary to replace the tape, proceed as follows:

With power ON push TAPE RELEASE (17) to the right; the tape loop will automatically release and pop out of the mechanism.

When replacing a pre-recorded loop, be sure that the same direction of rotation used during recording is retained. (Fitting of Tape Loop - see paragraph 4.5) If rotation during recording is not known, operate tape in both directions to determine proper rotation. The tape is not harmed by being run backward.

NOTE

Clean the record/playback head prior to the fitting of a new unused tape loop or after every 10 hours of operation (see paragraph 6-4).

6. MAINTENANCE

6-1. TAPE LOOP

The tape speed of approximately 6 m/s (240 inches/sec) causes minor wear of the magnetic tape loop but the life expectancy is normally greater than 10 hours of operation. It is recommended that the tape is checked regularly.

Of particular importance for trouble-free operation of the unit is careful cleaning of the recording/playback heads, the drive capstan and the tape idler.

6-2. INDICATIONS OF FAULTY OPERATION

After long periods of operation, interference signals may become superimposed over the signal under test which originate from wear of the tape or dirt on the heads and rollers.

It is recommended, therefore, that when such faults are observed or at intervals of approximately 10 hours the unit is re-checked as shown in paragraph 6-3.

6-3. PLAYBACK CHECK

A control circuit continuously checks the condition of the tape and the playback quality. If faults appear then the playback indicator lamp starts to flash as a warning to the operator. The causes are:

1) The tape loop is worn and requires replacement (see paragraph 5-13).

2) The recording/playback head is dirty and requires cleaning (see paragraph 6-4).

3) The drive capstan and idler are dirty and require cleaning (see paragraph 6-5).

6-4. CLEANING OF HEADS

A flock-sprayed cleaning loop is supplied with the unit to clean the recording/playback head (see Fig. 8). The outer flock-sprayed tape surface should be moistened with video cleaning spray or alcohol and subsequently used like any normal tape loop. Cleaning is completed after approximately 20 seconds. The cleaning tape loop should then be removed from the unit.

6-5. CLEANING OF DRIVE UNIT

If the oscilloscope ground reference base line fails to remain straight during playback, but exhibits amplitude noise, it is a fault probably caused by slipping of the tape loop. The effect can be cleared up by cleaning the drive capstan and tape idler as follows:

a) Remove the tape loop.

b) Remove four screws holding the drive unit cover and remove cover.

c) Moisten the cleaning sticks with video spray or alcohol and thoroughly clean the drive roller and tape guide.

d) Replace drive unit cover and four screws.

NOTE

Clean heads and rollers after each 10 hours or less of operation. Clean more frequently in dusty environments.

7. PERFORMANCE ASSURANCE AND BENCH TEST

7-1. REQUIRED TEST EQUIPMENT:

Oscilloscope, Dual Trace, 15 MHz, 5 mV	Ballantine 1066A
Oscillator	Hewlett Packard 651B
Voltmeter, Digital	Ballantine 3600A
Capacity Meter	Ballantine 550 or Tektronix 130
Distortion Analyzer	Hewlett Packard 300A
Voltmeter, True RMS	Ballantine 323
Multimeter	Simpson 260

7-2. RECORD MODE CHECK:

1) Warm up instrument for 10 minutes
2) Connect the oscilloscope to the signal output of the 7050A
3) Connect the oscillator to the signal input of the 7050A
4) Check GRD REF control and set ground reference on oscilloscope display
5) Amplifier checks:
   a) Set VOLTS/DIV switch on the 7050A to 100 mV/Div
   b) Set oscillator input to the 7050A to 1 kHz sine waves with 1 volt ±30 mV peak-to-peak amplitude (check with scope and thru mode on 7050A)
6) Output signal shall be 1 volt ±30 mV peak-to-peak. If output has greater error adjust AMP CAL until the 7050A is in calibration
7) Disconnect the scope from the output of the 7050A and connect the distortion analyzer
8) Harmonic distortion shall be less than 1.5%
9) Disconnect the distortion analyzer and connect the Ballantine 323 True RMS Voltmeter to the signal output of the 7050A. Use short low capacity leads
10) Set the VOLTS/DIV switch on the 7050A to 100 mV/Div
11) Apply a 500 mV peak-to-peak 1 kHz sine wave signal to the signal input of the 7050A
12) Note and record the output True RMS voltage reading on the Ballantine 323 Voltmeter (approximately 175 mV)
13) Change the oscillator frequency to 100 kHz and precisely maintain the peak-to-peak amplitude set at 1 kHz
14) Note and record the output voltage reading on the Ballantine 323 voltmeter. The 100 kHz reading shall be down less than 30% from the 1 kHz voltmeter reading. (This checks the 100 kHz 3 dB point for system bandwidth)
15) Disconnect the oscillator and connect the Simpson 260 multimeter to the signal input corrector of the 7050A. The input resistance for each of the 9 VOLTS/DIV ranges shall be 1 megohm ±50 kohm
16) Disconnect the multimeter and connect the capacitance meter to the input of the 7050A. The input capacity shall be 36 pF ±1 pF for each of the 9 ranges of the VOLTS/DIV switch

17) Measure input resistance of the TRIGger INput of the 7050A with the multimeter. It must be 1 megohm ±100 kohm
18) Measure input capacitance of the trigger input of the 7050A with the capacitance meter. It must be equal to or less than 36 pF. (excitation voltage of the capacitance meter should be approximately 200 mV)

7-3. CERTIFICATION CHECK OF TRANSFER FROM RECORD TO PLAYBACK:

1) Set 7050A transfer mode to INTernal
2) Apply approximate amplitude of 1 kHz sine wave to the Signal Input BNC
3) Observe output on oscilloscope and check internal triggering in + slope and — slope
4) Parallel connect the sine wave oscillator to both the SIGNAL and the TRIGGER INputs. Use a sine wave amplitude greater than 1 volt peak-to-peak
5) Set the 7050A transfer mode to EXT AC
6) Observe the output signal on the oscilloscope and check external trigger in + slope and — slope
7) Check push button operation of manual transfer from Record to Playback and back to Record modes. Observe function of indicator lamps.

7-4. CHECK TRANSFER DELAY:

1) Connect 1 kHz sine wave signal to input of 7050A and oscilloscope to signal output
2) Record and play back with maximum and minimum transfer delay. Observe the following displays on the scope.

7-5. STORAGE TIME AND BLANKING PULSE INT MOD CHECK:

1) Display the output of the 7050A on the oscilloscope thru channel A
2) Set the 7050A in the Playback mode
3) Observe the storage time to be 20 ms ±0.5 ms
4) Connect the blanking signal from the rear panel mounted connector of the 7050A to channel B of the oscilloscope
5) The positive going blanking pulse shall be greater than 13 volts in amplitude with a duration of 0.5 ms ±0.05 ms
6) Disconnect the blanking signal from channel B of the scope
7) Connect channel B to the trigger output of the 7050A
8) The trigger shall measure more than 13 volts peak amplitude

7-6. PLAYBACK MODE CHECK:

1) Connect Wavetek 110 function generator to input of 7050A. Apply 1 kHz sine wave with 1 volt peak-to-peak input
2) Set VOLTS/DIV switch to 100 mV/cm on 7050A
3) Connect oscilloscope to signal output connector of the 7050A and observe 1 volt peak-to-peak signal with minimal distortion
4) Disconnect function generator from input of 7050A and set signal input coupling switch to GND
5) Observe output noise level of 7050A on oscilloscope. Noise peaks shall be less than 20 mV peak
6) Vary the horizontal positioning control on the 7050A. Trigger the scope externally from the 7050A. Note that the displayed waveform moves more than 16 ms on the scope trace.

8. CALIBRATION PROCEDURES

8-1. REQUIRED TEST EQUIPMENT:

Oscilloscope, Dual Trace, 15 MHz, 5 mV	Ballantine 1066B
Attenuator Probe (10:1)	Ballantine 10601A
Multimeter	Simpson 260
Digital DC Voltmeter	Ballantine 3600A
Distortion Analyzer	Hewlett Packard 300A
Low Distortion Oscillator	Hewlett Packard 651B
Capacity Meter	Ballantine 520 or Tektronix 130
AC True RMS Voltmeter	Ballantine 323
Function Generator	Wavetek 110
Auto Transformer for Power Line	General Radio W5MT3AW

8-2. INITIAL SETTINGS OF PANEL CONTROLS ON THE 7050A:

1) Power on
2) Set signal mode switch to TAPE
3) Set 7050A to record (push record button and observe green indicator lamp)
4) Center the following controls:
   Trigger Level
   GND Reference
   AMP Cal (screwdriver adjust)
5) Set VOLTS/DIV attenuator switch to 100 mV/Div
6) Set signal input coupling switch to DC
7) Set transfer switch to EXTernal AC
8) Set SLOPE switch to +

8-3. POWER SUPPLY ADJUSTMENTS:

Set Power Line to 115 volts/230 volts

1) +15 volt adjust:
   a) Use the Ballantine 3600A 0.01% DVM. Connect it from any +15 volt point to ground
   b) Adjust R204 for 15 volts ±10 mV

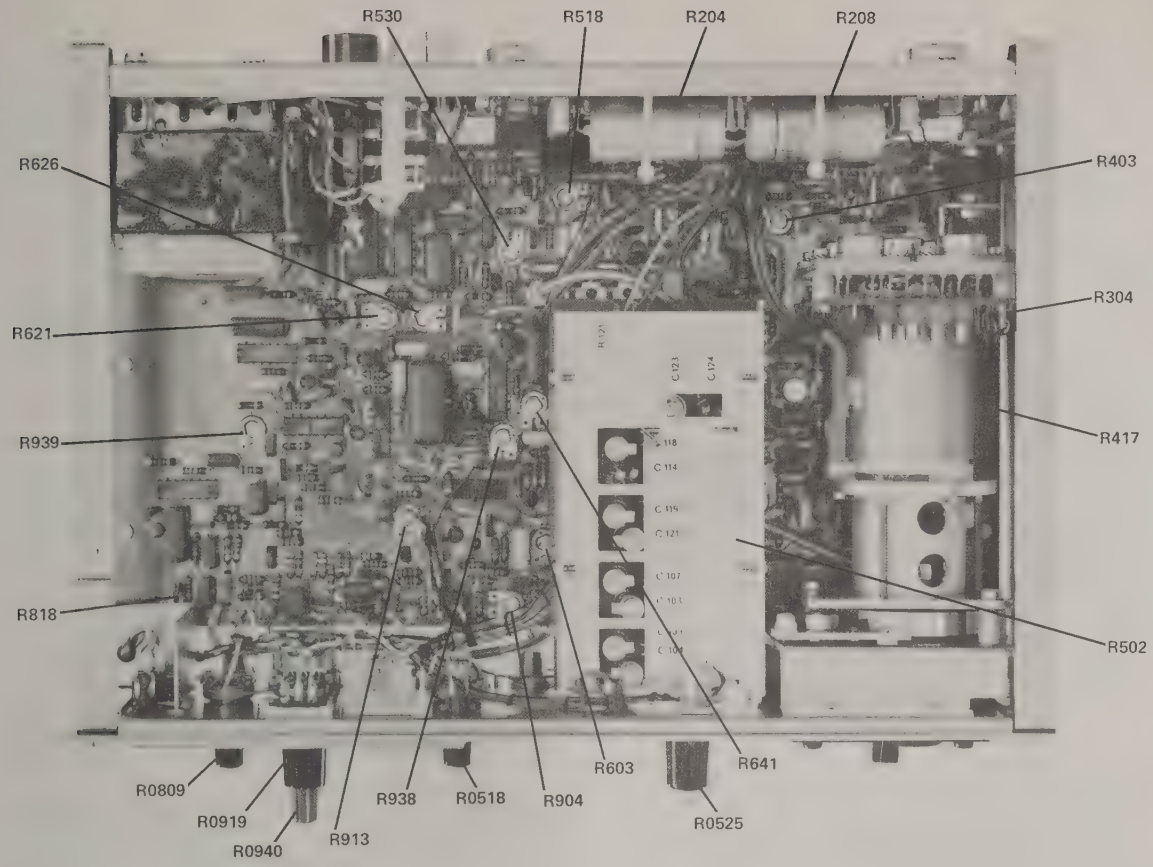


Figure 6. 7050A Internal View

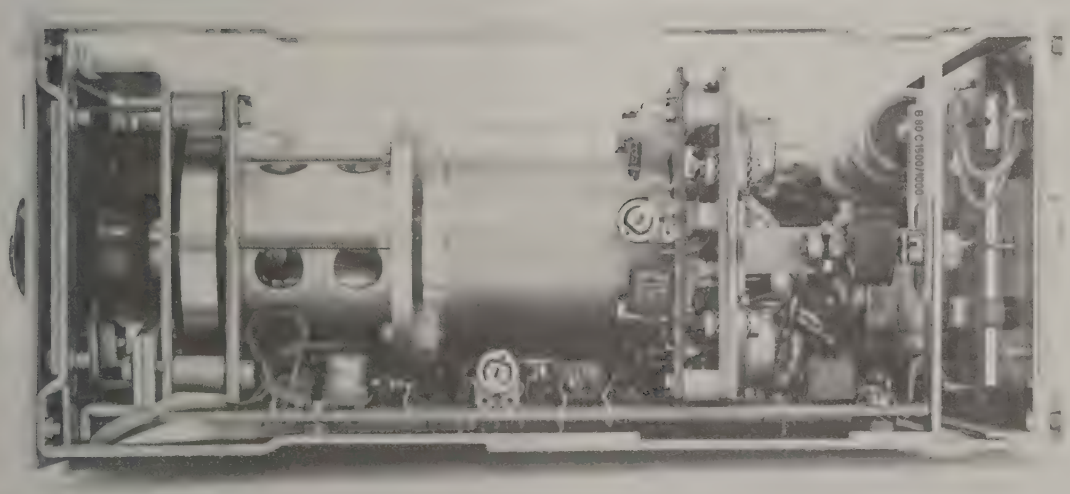


Figure 7. Tape Drive Unit

2) +15 volt supply ripple measurement:
   a) Use Ballantine 323 True RMS voltmeter and connect from an +15 volt point ground
   b) Ripple voltage shall be less than 10 mV RMS
3) −15 volt adjust:
   a) Use Ballantine 3600A 0.01% DVM and connect from any −15 volt point to ground
   b) Adjust R208 for −15 volts ±10 mV
4) −15 volt supply ripple measurement:
   a) Use Ballantine 323 True RMS voltmeter and connect from any −15 volt point to ground
   b) Ripple voltage shall be less than 10 mV RMS
5) Checking +5 volt power supply:
   a) Use Ballantine 3600A DVM and connect from any +5 volt point to ground
   b) Reading shall be between +5.400 volts and 4.750 volts
6) Power input current check:
   a) 110 volts line voltage;
      Record Mode 360 mA (approx.)
      Playback Mode 300 mA (approx.)
   b) 220 volts line voltage;
      Record Mode 180 mA (approx.)
      Playback Mode 150 mA (approx.)

8-4. CALIBRATION AND CERTIFICATION OF THE MODULATOR CIRCUITRY:

1) Set the signal input coupling switch to GND
2) Set 7050A to "Record"
3) Set Potentiometer R403 fully clockwise (viewed from component side of circuit board)
4) Connect the Ballantine 3600A DVM to test point 1
5) Adjust R121 to have the DVM read 0 volts ±20 mV
6) Connect Ballantine 5500A AutoMetronic Digital Counter to test point 2. Set counter for frequency measurement
   Measured frequency must be 750 kHz ±35 kHz (715 to 785 kHz)
7) Connect Ballantine 1066A oscilloscope to test point 3 thru 10601A attenuator probe
8) Set scope:
   a) Attenuator to 2 V/cm
   b) Time/cm to 0.5 μs/cm
   c) Trigger Internal (auto)
9) Adjust R417 for a 1:1 ratio waveform

8-5. CALIBRATION AND CERTIFICATION OF THE DEMODULATOR CIRCUITRY

1) Set signal input coupling switch of the 7050A to AC
2) Set 7050A into the "Record" mode
3) Set VOLTS/DIV switch to 4 mV/cm
4) Connect signal input BNC with shielded BNC cable (Ballantine 12249D) to function generator Wavetek model 110
5) Set the function generator to 1 kHz and 20 mV peak-to-peak square wave
6) Connect the Ballantine 1066A oscilloscope to the signal output connector of the 7050A with a shielded BNC cable (Ballantine 12249D)
7) Set the oscilloscope controls:
   a) Volts/cm input attenuator to 100 mV/cm
   b) Time/cm time base switch to 0.1 ms/cm
   c) Trigger internal (auto-AC)
   d) Amplifier input coupling to AC
8) Adjust R530 for best square wave response
9) Disconnect the Wavetek 110 from the 7050A and replace it with a low distortion sine wave oscillator such as the Hewlett-Packard 651B
10) Set the sine wave oscillator to 2 kHz and 40 mV peak-to-peak (≈14 mV RMS)
11) Disconnect the oscilloscope from the 7050A output. Connect the distortion analyzer Hewlett-Packard 300A to the output connector with fully shielded cables
12) Adjust R403 in the 7050A for minimum harmonic distortion. Distortion must not exceed 1.5%
13) Disconnect the distortion analyzer and reconnect the oscilloscope to the output of the 7050A with a shielded cable (Ballantine 12249D) Adjust scope controls as above but set input attenuator to 200 mV/cm
14) Adjust R518 (Amp Cal panel screwdriver adjustment) for output voltage of 1 volt peak-to-peak (5 cm of vertical deflection)
15) Reset the signal input coupling switch on the 7050A to GND
16) Set R525 the GND-REF control to mid range
17) Adjust the oscilloscope controls:
   a) Input coupling DC
   b) Time/cm Time base switch to 0.1 ms/cm
   c) Trigger Int. (auto-AC)
   d) Volts/cm input sensitivity 5 mV/cm
18) Adjust R526 for output dc level of 0 V ±10 mV
19) Repeat the adjustment of R526 to be certain of its validity

8-6. INPUT ATTENUATOR COMPENSATION

1) Set the signal input coupling switch of the 7050A to AC
2) Connect the Wavetek 110 to the signal input connector and apply a 1 kHz square wave to the 7050A
3) Connect the Ballantine 1066A oscilloscope to the output of the 7050A. Set the scope controls:
   a) Volts/cm to 100 mV/cm
   b) Time/cm to 0.5 ms/cm
   c) Trigger internal (auto-AC)
4) Set the VOLTS/DIV switch on the 7050A to 4 mV/cm
5) Apply a 20 mV square wave from the Wavetek 110. 5 cm peak-to-peak deflection on the oscilloscope
6) Adjust C123 for best square wave shape
7) Disconnect the function generator
8) Connect the Ballantine 550 capacitance meter directly to the input of the 7050A. Measure input capacity of 7050A
9) Adjust C124 until the input capacity is 36 pF ±0.5 pF on the 4 mV/div range

NOTE: All Test Points are identified on the bottom of the main printed wiring board. They are accessible with an oscilloscope probe from either side of the board.

10) Disconnect the capacitance meter
11) Reconnect the Wavetek 110 function generator
12) Switch the 7050A input attenuator to 10 mV/Div and adjust C118 for best square wave response as shown on the oscilloscope
13) Disconnect the function generator and reconnect the capacitance meter. Set C114 for 36 pF ±0.5 pF input capacity. Reconnect the function generator and continue as above in the following sequence:
Note increase in the output amplitude of the function generator to maintain approximately 5 cm p-p deflection of the oscilloscope

20 mV/Div – adjust C119
40 mV/Div – adjust C107
100 mV/Div – adjust C107 and C118
200 mV/Div – adjust C107 and C119
400 mV/Div – adjust C108
1V/Div – adjust C108 and C118
2V/Div – adjust C108 and C119

14) Carefully recheck all compensation adjustments to be certain optimum adjustments have been performed
15) Reconnect the capacitance meter and adjust input capacity of the 7050A to 36 pF ±0.5 pF on the following ranges

10 mV/Div – adjust C101
20 mV/Div – adjust C111
40 mV/Div – adjust C103
400 mV/Div – adjust C104

16) Recheck input capacity on all attenuator ranges. Input capacity must be 36 pF ±0.5 pF on each range

8-7. ADJUSTMENT AND CERTIFICATION PROCEDURE FOR RECORDING HEAD AND ERASE HEAD:

1) For preliminary mechanical adjustments see figure 8
2) Adjust support plate 1. Use screws 4,5, and 10 to separate support plate 1 0.5 mm (0.002 inches) from the mounting surface
3) Adjust support plate 2. Use screws 1,2, and 3 to separate support plate 2 1.5 mm (.006 inches) from the mounting surface
4) Apply power to the 7050A
5) Check magnetic tape loop release and function
6) Insert a magnetic tape loop into the recorder
7) Manipulate the tape release lever to check free and ready tape release functions

8-8. FINAL CALIBRATION:

1) Connect the Ballantine 1066A oscilloscope to the 7050A
Set the scope:
a) Trigger – Internal
b) Signal input coupling – AC
c) Time/cm – 2 ms/cm
d) Volts/cm – 50 mV/cm
2) Connect the trigger output of the 7050A to the external trigger input BNC of the scope with a shielded BNC cable (Ballantine 12249D)
3) Connect channel A of the oscilloscope to testpoint 4 on the main printed circuit board of the 7050A through a 10:1 attenuator probe. (Ballantine 10601A)
4) Install a magnetic tape
5) Adjust screw number 1 so that the magnetic tape is exactly at the height of the record head
6) Adjust screws 2 and 3 so that the magnetic tape runs parallel to the record head
7) Adjust screws 9 and 11 so that the record head is exactly perpendicular to the magnetic tape.
8) Adjust excentric screw 12 to bring the recording head into contact with the tape. The tape must lightly touch the surface of the recording head
9) Lock all previous adjustments using screws 6,7, and 11
10) Move the erase head close to the magnetic tape. The tape must not touch the head. Spacing between tape and head is to be 0.1 mm ±0.05 mm (.004 ±0.002 inches)
11) Lock the erase head spacing with screw 8

8-9. CERTIFICATION OF HEAD ALIGNMENT:

1) Set the 7050A to "Record"
2) Record 100 kHz sine wave on the tape at peak-to-peak amplitude 10 times the 7050A VOLTS/DIV switch setting
3) Transfer the 7050A to "Playback" mode
4) Connect oscilloscope to the signal output connector of the 7050A. The 100 kHz signal on the scope shall be approximately 2 volts peak-to-peak at absolute maximum output (i.e. clipping level) of the 7050A
5) If maximum output is not present check the calibration of input signal and the scope. If this does not show an error then:
a) Lightly loosen screws 6,7, and 11 but keep spring washers under light compression
b) Carefully adjust screws 1,2,3,4,5,9,10, and excentric 12 for optimized high frequency output amplitude from the 7050A
c) After these "touch up" adjustments tighten locking screws 6,7, and 11
6) The output wave form displayed on the oscilloscope shows a ground reference base line followed by a pulse interval for playback ground reference. Adjust R638 to make this latter pulse internal 0.5 msec in duration
7) The trigger output of the 7050A will now have a repetition frequency of approximately 50 Hz and will have an amplitude of 13 volts when measured into an open circuit (use Ballantine attenuator probe 10601A to connect the 7050A trigger output pulse to the scope)
8) Reconnect the 7050A trigger output to the external trigger input of the scope

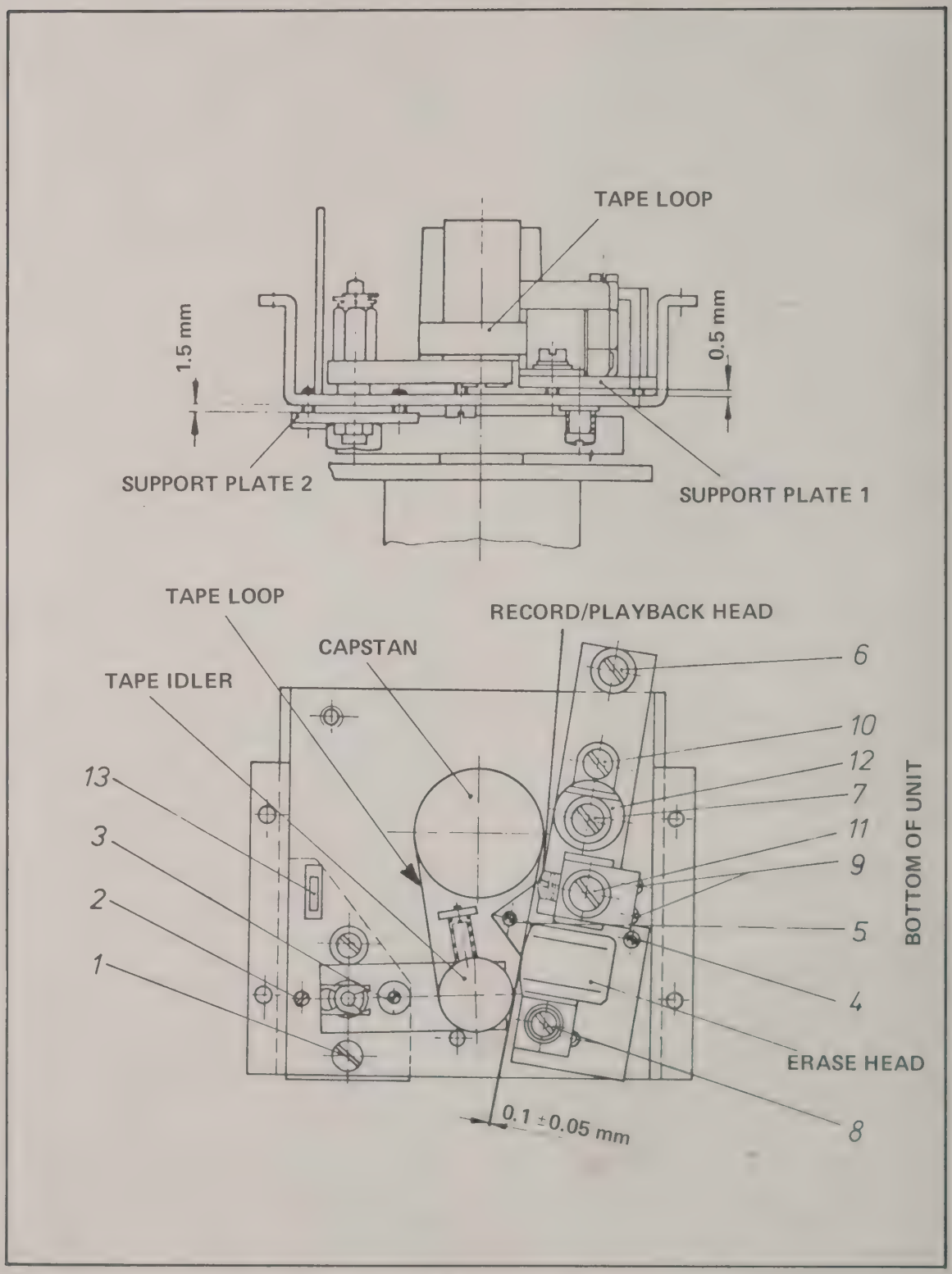


Figure 8. Recording Heads and Tape Drive Mechanism

9) Set the scope to external + trigger source and observe stable triggering of the scope trace
10) Should there be no trigger impulse output from the 7050A, then move the erase head closer to the tape but do not have the erase head touch the tape.
11) If necessary, repeat record head alignment procedures
12) Check tape release operation. Should this require readjustment, then the entire head alignment procedure must be repeated
13) Connect the oscilloscope channel B input to the intensity modulation BNC connector on the rear of the 7050A. (Use cable Ballantine 12249D)
14) Check that the intensity modulation pulse is present with amplitude greater than 13 volts

8-10. ADJUSTMENT AND CERTIFICATION OF THE PLAYBACK AMPLIFIER:

1) Set the VOLTS/DIV switch on the 7050A to 4 mV/Div
2) Set the signal input coupling switch to dc
3) Connect the Wavetek 110 function generator to the signal input connector of the 7050A. Set the Wavetek to 2 kHz square wave of 20 mV peak-to-peak amplitude
4) Connect the Ballantine 1066A oscilloscope to the signal output connector of the 7050A with a shielded cable
   Set the scope:
   a) Input volts/cm to 200 mV/cm
   b) Time base to 0.2 ms/cm
   c) Trigger external + from trigger output of 7050A
   d) Input signal coupling switch to dc
5) Adjust R502 for best square wave response

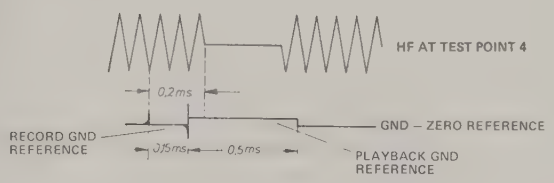
8-11. ADJUSTMENT OF MOTOR SPEED:

1) Set the input coupling switch of the 7050A to GND
2) Connect the Ballantine 1066A oscilloscope to test point 4 with 10:1 attenuator probe (Ballantine 10601A)
   Set scope controls:
   a) Input sensitivity 50 mV/cm
   b) Time base 2 ms/cm
   c) Trigger external + with trigger from 7050A
   d) Input coupling AC
3) Adjust R304 in the motor circuitry until the scope shows that the tape runs one revolution in 20.5 ms
4) Switch from record to playback and again note that R304 has been properly adjusted for a tape repetition period of 20.5 ms

8-12. ADJUSTMENT AND CERTIFICATION OF THE TRANSFER LOGIC:

1) Set the signal input coupling switch of the 7050A to GND
2) Connect channel A of the Ballantine 1066A dual trace oscilloscope to test point 4 thru the 10:1 attenuator probe
3) Connect channel B to the signal output BNC connector of the 7050A thru a shielded cable (Ballantine 12249D)
4) Connect the external trigger input of the scope to the trigger output of the 7050A thru a shielded cable
5) Set oscilloscope controls:
   a) Trigger external +
   b) Input sensitivity
      Channel A 50 mV/cm
      Channel B 100 mV/cm
   c) Input coupling switch
      Channel A AC
      Channel B DC
   d) Time base 0.1 ms/cm
6) Adjust R621 to offset the PLAYBACK ground level from the marker pip
7) Adjust R641 so that the RECORD ground level interval is 0.2 ms. After each adjustment transfer from RECORD to PLAYBACK to check performance
8) Adjust R938 so that the marker pip is 0.3 ms long
9) Adjust R626 so that the PLAYBACK ground level marker is 0.5 ms long
10) Readjust R621 so that the PLAYBACK ground level marker moves to cover the reference marker pip.

The final setting is:



8-13. ADJUSTMENT OF THE TRIGGER CIRCUITS:

1) Set the 7050A to RECORD and set signal input coupling switch to GND
2) Connect channel A of the Ballantine 1066A oscilloscope to test point 7. Probe is desirable but not required
3) Connect channel B of the scope to test point 8
4) Set scope controls:
   a) Input sensitivity 2 V/cm
   b) Input coupling DC
   c) Trigger – Internal – Auto
5) Set input coupling switches to GND
6) Position both traces to the bottom of the scope graticule to establish ground reference. Again reset both input coupling switches to DC
7) Set the transfer mode switch on the 7050A to INT and the trigger level control (R919) to mid rotation
8) Adjust R904 until both scope traces are superimposed on one another
9) Set transfer mode switch on the 7050A to external AC
10) Adjust R913 until both scope traces are again superimposed
11) Set R818 fully counter clockwise
12) Connect the EXT TRIG input of the scope to the trigger output of the 7050A with a shielded cable
13) Set the scope trigger to EXT + and connect channel A of the scope to the signal output BNC of the 7050A
14) Note the position of the baseline on the scope

15) Rotate the horizontal position control knob (R809) on the 7050A completely from end to end. Notice if the baselines on the scope jump or become erratic. Readjust R819 by turning clockwise while simultaneously fully rotating the horizontal position control. Turn R819 only far enough to prevent all trigger and baseline instability over the entire rotation range of the horizontal position control

8-14. ADJUSTMENTS FOR THE TRANSFER DELAY CIRCUITRY:

1) Set the signal input coupling switch to GND
2) Connect the Wavetek 110 function generator to the input connector of the 7050A and apply a 1 kHz sinewave of 40 mV peak-to-peak amplitude
3) Set the transfer mode selector switch of the 7050A to INT
4) Set transfer DELAY control (R940) fully clockwise
5) Press the RECORD push button
6) Switch the signal input coupling switch to DC. The instrument should transfer from record to playback
7) The time duration of the recorded 1 kHz sinewave is to be displayed on an oscilloscope as in normal operation
8) Adjust R939 to give a recording time of 4 ms ±0.5 ms

Note: After each adjustment of R939 repeat all the previous adjustments and checks in this section to certify proper transfer operation

8-15. ADJUSTMENT OF THE AUTOMATIC WARNING MODE (BLINKING PLAYBACK LAMP):

1) Set the input signal coupling switch to GND
2) Connect the Ballantine 1066A oscilloscope to test point 4 thru a 10:1 attenuator probe (Ballantine 10601A)
3) Set the oscilloscope controls:
   a) Input sensitivity 20 mV/cm
   b) Time base 2 ms/cm
   c) Input coupling switch AC
   d) Trigger external + auto (from trigger output of 7050A)
4) Transfer the operating mode of the 7050A from record to playback
5) Misadjust the alignment of the recording head with excentric screw 12 until the H.F. displayed on the scope drops to approximately 200 mV peak-to-peak
6) Adjust R603 until playback lamp just begins to blink
7) Carefully readjust excentric screw 12 for maximum H.F. amplitude. See Section 8-9

8-16. CERTIFICATION OF "THRU" MODE FOR THE INPUT SIGNAL:

1) Set the signal mode switch of the 7050A to thru
2) Set the signal input coupling switch to GND
3) Connect the Wavetek 110 function generator to the signal input connector of the 7050A and apply a 1 kHz sinewave with 1 volt peak-to-peak amplitude
4) Connect the Ballantine 1066A oscilloscope to the signal output connector. The input and output signals to and from the 7050A must be identical

9. REMOVAL FROM CABINET

To disassemble the 7050A unplug the powerline cord and remove the screws in each of the four corners on the rear panel. Then remove the rear panel plate. Stand the unit on its rear with front panel facing up. Grasp the front panel BNC connectors or knobs and carefully withdraw the instrument upward from its case.

To remove knobs simply pry off the end button of the knob. Hold the knob firmly with your fingers or a padded tool and use a screwdriver to loosen the clutch device holding the knob to the shaft.

CAUTION

Do not loosen or tighten knob clutch by bearing against the end rotational stop of switches and potentiometers — always grasp the knob body firmly.

10. PACKING

The 7050A is a rugged instrument built to perform in severe environments. If the unit is to be shipped or stored for long periods of time the following packing procedure is recommended:

a) Place the 7050A into an oversize plastic bag and seal the bag.

b) Place the bagged 7050A into a heavy duty corrugated cardboard box. The box must contain at least 2 inches of rubberized hair or equivalent cushion on all six sides of the instrument. The counter must fit snugly into the cushion and the cushion must fit into the box to prevent any movement of the instrument in transit.

c) Place the instruction manual into the box. If accessories are also to be packed put them into a separate plastic bag and pack into the cushion leaving at least two inches of cushion between the instrument and the accessories as well as an extra cushion between accessories and the box.

d) Seal the box fully with 2 or 3 inch wide packing tape.

e) Properly label and address outside of box with a typed label or an indelible pen.

If shipment is to the factory, notify Ballantine in advance and include detailed reasons for return inside box along with your name, firm and full mailing address. Also include your phone number and purchase order number.

Ship prepaid by United Parcel Service or Registered Air Parcel Post to:

Ballantine Laboratories
90 Fanny Road
Post Office Box 97
Boonton, NJ USA 07005

11. REPLACEMENT PARTS LIST

The replacement parts listed are available from the vendors listed or from Ballantine Labs. at the address shown above.

When ordering replacement parts always give the following information:

a) Model number
b) Serial number
c) Ballantine Part number
d) Schematic Symbol number
e) Identification of the part

Ballantine will do its best to improve the instrument and make changes in style of components and replacement parts. Replacement parts may differ in appearance from those found in your instrument but are always equal or superior in performance. Where necessary minor mechanical modifications may be required in the replacement of components.

Parts are generally available locally for most replacements. The parts list calls out the recommended vendors where applicable.

The following parts coding are used:

CVC	Capacitor, Variable, Ceramic
CCT	Capacitor, Ceramic, Tubular
CFP	Capacitor, Fixed, Plastic
CCD	Capacitor, Ceramic, Disc
CYF	Capacitor, Mylar, Foil
CSF	Capacitor, Polystyrene, Foil
CMD	Capacitor, Mica, Dipped
CMM	Capacitor, Mica, Molded
CEA	Capacitor, Electrolytic, Aluminum
CET	Capacitor, Electrolytic, Tantalum
DGP	Diode, General Purpose
DZG	Diode, Zener, General Purpose
DRP	Diode, Bridge, Power
FLT	Filter
ICP	Integrated Circuit
TRQ	Transistor
RFF	Resistor, Fixed, Film
RFC	Resistor, Fixed, Composition
RVC	Resistor, Variable, Composition
RFW	Resistor, Fixed, Wirewound
SWG	Switch
TRD	Transducer
CLV	Coil, Variable
THR	Thermistor
TRD	Transducer
LMB	Lamp
TRX	Transformer

Resistors may generally be replaced by Corning Electronics (CGW) type N-55 and C-32. Allen Bradley composition resistors type EB are also used. Resistors RVC are generally Amperex Series E097AD.

Capacitors CYF are Sprague Series 225P and Amperex Series 280MAE. Voltage is 100 V dc and tolerance ±20%. Capacitors CSF are Siemes Styroflex Series B31110 125 volts dc. Capacitors CYF are generally Sprague Series 196D.

INPUT ATTENUATOR AND DC INPUT AMPLIFIER (Figure 9)

SYMBOL	DESCRIPTION	MFR	BLI P/N
C101	CVC 0.5 to 6pF	BLI	07500480A
C102	CCT 7.5pF	CRL	07025140A
C103	CVC 1.5 to 10pF	BLI	07500470A
C104	CVC 1.5 to 10pF	BLI	07500470A
C105	CFP 0.1uF 400 volts Tubular 20%	Sprague	07100770A
C106	CCT 3pF	Erie	07022780A
C107	CVC 1.2 to 7.2pF	BLI	07500490A
C108	CCT 10pF	Erie	07025250A
C109	CVC 1.2 to 7.2pF	BLI	07500490A
C111	CVC 0.5 to 6pF	BLI	07500480A
C112	CMM 47pF	BLI	07022930A
C113	CSF 1.5nF Polystyrene	BLI	07100710A
C114	CVC 0.5 to 6pF	BLI	07500480A
C116	CCT 3pF	Erie	07022780A
C117	CCT 7.5pF	CRL	07025140A
C118	CVP 1.5 to 10pF	BLI	07500470A
C119	CVP 1.5 to 10pF	BLI	07500470A
C121	CVP 1.2 to 7.2pF	BLI	07500490A
C122	CCT 10pF	Erie	07025250A
C123	CVC 5.5 to 65pF	Amperex	07091540A
C124	CVC .5 to 12.5pF	BLI	07500810A
C129	CSF 20 pF Polystyrene	Siemens	07500690A
C131	CYF 10nF (0.01uF)	Sprague	07100750A
C132	CCT 10pF	Erie	07025250A
C133	CCD 10nF (0.01uF)	CRL	07095760A
D101	DGP 1N916B/FD600	Fairch	05079200A
D102	DGP 1N916B/FD600	Fairch	05079200A
D103	DGP 1N916B/FD600	Fairch	05079200A
D104	DGP 1N916B/FD600	Fairch	05079200A
IC101	ICP FM3956 (Dual FET)	Natl Semi	24100070A
IC102	ICP 709C	Natl Semi	24094260A
T101	TRQ BF245A (FET)	TI	10100240A
R101	RFF 100k 1/4W 1%	CGW	12125000A
R102	RFF 990k 1/2W 1%	CGW	12026420A
R103	RFF 111.1k 1/4W 1%	CGW	12027470A
R104	RFF 10.1k 1/4W 1%	Pyrofilm	12126531A
R106	RFF 600k 1/2W 2%	CGW	12016940A
R107	RFF 800k 1/4W 1%	CGW	12088130A
R108	RFF 665k 1/2W 1%	CGW	12125790A
R109	RFF 249k 1/4W 1%	CGW	12125380A
R111	RFF 178k 1/4W 1%	CGW	12125240A
R112	RFF 825k 1/2W 1%	CGW	12125880A
R118	RFF 100k 1/4W 1%	CGW	12125000A
R119	RFF 100k 1/4W 1%	CGW	12125000A
R121	RVC 20k 1/4W Pot., DC Balance	Amphenol	09068950A
R122	RFF 10 1/4W 1%	CGW	12121000A
R123	RFF 237k 1/4W 1%	CGW	12125360A
R124	RFF 46.4 1/4W 1%	CGW	12124640A
S101	SWG Input Attenuator Rotary Switch, 9 Positions, 4 poles, V/Div	BLI	25500190A
S0102	SWG Slide Switch, Miniature DPDT, Mode	BLI	25500160A
S0103	SWG Slide Switch, Miniature DP3T, Input Coupling	BLI	25500170A

MODULATOR AND BUFFER AMPLIFIER (Figure 9)

SYMBOL	DESCRIPTION	MFR	BLI P/N
C402	CSF 20pF Polystyrene	Sienens	07500690A
C403	CSF 330pF Polystyrene	Siemens	07100700A
C404	CSF 330pF Polystyrene	Siemens	07100700A
C405	CET 10uF 25 volts Tantalum	Sprague	07100530A
C406	CCD 10nF (0.01)	CRL	07095760A
C407	CYF 0.1uF	Sprague	07100770A
C408	CYF 0.1uF	Sprague	07100770A
C409	CYF 0.47uF	Amperex	07100630A
D401	DGP 1N4154/FD600	TI	05079200A
D402	DGP 1N4154/FD600	TI	05079200A
D403	DGP 1N4154/FD600	TI	05079200A
D404	DGP 1N4154/FD600	TI	05079200A
D405	DGP 1N4154/FD600	TI	05079200A
D406	DGP FD600	Fairchild	05079200A
D407	DGP FD600	Fairchild	05079200A
D408	DGP 1N4154/FD600	TI	05079200A
D409	DGP 1N4154/FD600	TI	05079200A
R401	RFF 681 1/4W 1%	CGW	12122800A
R402	RFF 464 1/4W 1%	CGW	12122640A
R403	RVC 5k 1/4W Pot., dc level adj.	Amperex	09100360A
R404	RFF 1.78k 1/4W 1%	CGW	12123240A
R406	RFF 348 1/4W 1%	CGW	12122520A
R407	RFF 56.2k 1/4W 1%	CGW	12124720A
R408	RFF 17.8k 1/4W 1%	CGW	12124240A
R409	RFF 1.78k 1/4W 1%	CGW	12123240A
R410	RFF 348 1/4W 1%	CGW	12122520A
R411	RFF 1.47k 1/4W 1%	CGW	12123160A
R412	RFF 46.4k 1/4W 1%	CGW	12124640A
R413	RFF 150 1/4W 1%	CGW	12122170A
R414	RFF 10 1/4W 1%	CGW	12121000A
R415	RFF 348 1/4W 1%	CGW	12122520A
R416	RFF 1k 1/4W 1%	CGW	12123000A
R417	RVC 100k 1/4W Pot., mod. symmetry adj.	Amperex	09100420A
R418	RFF 1k 1/4W 1%	CGW	12123000A
R419	RFF 10k 1/4W 1%	CGW	12124000A
R420	RFF 215 1/4W 1%	CGW	12122320A
T401	TRQ 2N3646 NPN	Fairchild	10100210A
T402	TRQ 2N3646 NPN	Fairchild	10100210A
T403	TRQ 2N2484 NPN	RCA	10100220A
T404	TRQ 2N5323 PNP	RCA	10100230A
T405	TRQ 2N2484 NPN	RCA	10100220A
	TRD Record/Playback Magnetic Head	BLI	15500010A

PLAYBACK AMPLIFIER, DEMODULATOR AND LOW PASS FILTER (Figure 9)

SYMBOL	DESCRIPTION	MFR	BLI P/N
C501	CYF 1nF (.001uF)	Sprague	07100800A
C502	CYF 68nF (6800pF)	Amperex	07100620A
C503	CYF 33nF (3300pF)	Amperex	07100540A
C504	CYF 0.1uF	Sprague	07023570A
C505	CET 15uF 20 volts Tantalum	Sprague	07078150A
C506	CCD 10nF	CRL	07095760A
C507	CYF 0.1uF	Sprague	07100770A
C508	CYF 0.1uF	Sprague	07100770A
C509	CYF 0.1uF	Sprague	07100770A
C510	CYF 0.33uF	Sprague	07100760A
C511	CCD 10nF	CRL	07095760A
C512	CET 150uF 6 V	Sprague	07100520A
C513	CCD 10nF	CRL	07095760A
C514	CSF 220pF Polystyrene	Siemens	07100670A
C515	CSF 120pF Polystyrene	Siemens	07100680A
C516	CCD 10nF	CRL	07095760A
C517	CET 10uF 35 V	Sprague	07100530A
C518	CSF 316pF 2.5% Polystyrene	BLI	07500651A
C519	CSF 287pF 2.5% Polystyrene	BLI	07500661A
C520	CYF 15nF	Amperex	07100560A
C521	CYF 4.7nF	Sprague	07100790A
C522	CYF 6.8nF	Sprague	07100780A
C523	CYF 1.5nF	Sprague	07100740A
C526	CCD 10nF	CRL	07095760A
C527	CET 15uF 20 volt Tantalum	Sprague	07078150A
D501	DZP 1N4736 Zener Diode 13 V	Motorola	05100220A
D502	DGP 1N914	Motorola	05100020A
D503	DGP 1N914	Motorola	05100020A
D504	DGP 1N914	Motorola	05100020A
D505	DZP 1N4105 Zener Diode 11 volts	Motorola	05100230A
D506	DZP 1N4101 Zener Diode 8 volts	Motorola	05100240A
L501	CLV 0.210mH Adjustable	BLI	03500000A
L502	CLV 0.113mH Adjustable	BLI	03500010A
L503	CLV 0.261mH Adjustable	BLI	03500020A
R501	RFF 68.1k 1/4W 1%	CGW	12124800A
R502	RVC 50k 1/4W Pot., Waveshape Adj.	Amperex	09100390A
R503	RFF 4.64k 1/4W 1%	CGW	12123640A
R505	RFF 1k 1/4W 1%	CGW	12123000A
R506	RFF 196k 1/4W 1%	CGW	12125280A
R507	RFF 4.64k 1/4W 1%	CGW	12123640A
R508	RFF 562 1/4W 1%	CGW	12122720A
R509	RFF 2.4 1/4W 5%	CGW	12015820A
R510	RFF 5.0k 1/4W 1%	CGW	12123720A
R511	RFF 5.62k 1/4W 1%	CGW	12123720A
R512	RFF 464 1/4W 1%	CGW	12122640A
R513	RFF 46.4k 1/4W 1%	CGW	12124640A
R514	RFF 6.81k 1/4W 1%	CGW	12123800A

PLAYBACK AMPLIFIER, DEMODULATOR AND LOW PASS FILTER, Continued (Figure 9)

SYMBOL	DESCRIPTION	MFR	BLI P/N
R515	RFF 1k 1/4W 1%	CGW	12123000A
R516	RFF 464 1/4W 1%	CGW	12122640A
R517	RFF 10 1/4W 1%	CGW	12121000A
R518	RVC 2.5k 1/4W Potentiometer	BLI	09500410A
R519	RFF 2.15k 1/4W 1%	CGW	12123320A
R520	RFF 10 1/4W 1%	CGW	12121000A
R521	RFF 68.1k 1/4W 1%	CGW	12124800A
R522	RFF 1k 1/4W 1%	CGW	12123000A
R523	RFF 100 1/4W 1%	CGW	12122000A
R524	RFF 1k 1/4W 1%	CGW	12123000A
R525	RVC 500 1/4W Pot., GND-REF	BLI	09500400A
R526	RVC 1k 1/4W Pot., Output Level Adj.	Amperex	09100340A
R527	RFF 147 1/4W 1%	CGW	12122160A
R528	RFF 6.19k 1/4W 1%	CGW	12123760A
R529	RFF 1.47k 1/4W 1%	CGW	12123160A
R530	RVC 100 1/4W Pot., Shape Adj.	Amperex	09100430A
R531	RFC 1M 1/2W 5%	AB	12010100A
R532	RFF 10k 1/4W 1%	CGW	12124000A
R533	RFF 10 1/4W 1%	CGW	12121000A
R645	RFF 3.83k 1/4W 1%	CGW	12123560A
T501	TRQ 2N2484 NPN	RCA	10100220A
T502	TRQ 2N2484 NPN	RCA	10100220A
T503	TRQ 2N2484 NPN	RCA	10100220A
T504	TRQ 2N2484 NPN	RCA	10100220A
T505	TRQ 2N2484 NPN	RCA	10100220A
T506	TRQ 2N2484 NPN	RCA	10100220A
T507	TRQ 2N2484 NPN	RCA	10100220A
T508	TRQ 2N2484 NPN	RCA	10100220A
T509	TRQ BF247A FET	TI	10100240A
IC501	ICP TAA350	Amperex, Valvo, Siemens	24500080A
IC502	ICP 7412	TI	24100090A

HF CONTROL, TRANSFER LOGIC, PREAMPLIFIER (Figure 10)

SYMBOL	DESCRIPTION	MFR	BLI P/N
C601	CYF 6.8nF (6800pF)	Sprague	07100780A
C602	CET 15uF 20 V Tantalum	Sprague	07078150A
C603	CET 15uF 20 V Tantalum	Sprague	07078150A
C604	CET 22uF 5 V Tantalum	Sprague	07095690A
C605	CET 68uF 20 V Tantalum	Sprague	07095660A
C606	CCD 10nF	CRL	07095760A
C607	CET 15nF 20 V Tantalum	Sprague	07078150A
C608	CET 68uF 20 V Tantalum	Sprague	07095660A
C609	CYF 3.3nF	Sprague	07100720A
C610	CCD 10nF	CRL	07095760A
C611	CET 4.7uF 35 V Tantalum	Sprague	07100500A
C612	CYF 4.7nF	Sprague	07100790A
C613	CYF 4.7uF	Sprague	07100790A
C614	CYF 1.5nF	Sprague	07100740A
C615	CET 15uF 20 V Tantalum	Sprague	07078150A
C616	CCD 10nF	CRL	07095760A
C617	CYF 2.2uF	Sprague	07100730A
C618	CYF 1.5uF	Amperex	07100600A
C619	CYF 0.33uF	Sprague	07100760A
C620	CSF 43pF	Siemens	07100640A
C621	CYF 22nF	Amperex	07100550A
C632	CET 15uF 20 V Tantalum	Sprague	07078150A
C701	CET 15uF 20 V Tantalum	Sprague	07078150A
C702	CCD 10nF	CRL	07095760A
C703	CET 68uF 20 V Tantalum	Sprague	07095660A
C801	CYF 0.22uF	Amperex	07100570A
C802	CYF 0.22uF	Amperex	07100570A
D601	DGP 1N4154/FD600	TI	05079200A
D602	DGP 1N4154/FD600	TI	05079200A
D603	DGP 1N4154/FD600	TI	05079200A
D604	DGP 1N4154/FD600	TI	05079200A
D605	DGP 1N4154/FD600	TI	05079200A
D606	DGP 1N4154/FD600	TI	05079200A
D607	DGP 1N4154/FD600	TI	05079200A
D608	DGP 1N4154/FD600	TI	05079200A
D609	DGP 1N4154/FD600	TI	05079200A
D610	DGP 1N4154/FD600	TI	05079200A
D611	DGP 1N4154/FD600	TI	05079200A
IC601	ICP FCL101	Amperex, Valvo	24500120A
IC602	ICP 7400	TI	24094070A
IC603	ICP 7400	TI	24094070A
R601	RFF 2.4 1/4W 5%	IRC	12015820A
R602	RFF 1.47k 1/4W 1%	CGW	12123160A
R603	RVC 200 1/4W Pot., Playback Lamp Blink Adj.	Amperex	09100380A
R604	RFF 2.15k 1/4W 1%	CGW	12123320A
R605	RFF 2.15k 1/4W 1%	CGW	12123320A
R606	RFF 10k 1/4W 1%	CGW	12124000A
R607	RFF 100 1/4W 1%	CGW	12122000A
R608	RFW 2.4 1/4W 5%	IRC	12015820A
R609	RFF 14.7k 1/4W 1%	CGW	12124160A

HF CONTROL, TRANSFER LOGIC, PREAMPLIFIER, Continued (Figure 10)

SYMBOL	DESCRIPTION	MFR	BLI P/N
R610	RFF 2.61k 1/4W 1%	CGW	12123400A
R611	RFF 26.1k 1/4W 1%	CGW	12124400A
R612	RFF 2.61k 1/4W 1%	CGW	12123400A
R613	RFF 5.62k 1/4W 1%	CGW	12123720A
R614	RFF 5.62k 1/4W 1%	CGW	12123720A
R615	RFF 10 1/4W 1%	CGW	12121000A
R616	RFF 3.16k 1/4W 1%	CGW	12123480A
R617	RFF 5.62k 1/4W 1%	CGW	12123720A
R618	RFF 1k 1/4W 1%	CGW	12123000A
R619	RFF 5.62k 1/4W 1%	CGW	12123720A
R620	THR 50 ohm Thermistor	BLI	27500010A
R621	RVC 1k 1/4W Pot., Playback GND Position Adj.	Amperex	09100340A
R622	RFF 5.6k 1/4W 1%	CGW	12123720A
R623	RFF 10 1/4W 1%	CGW	12121000A
R624	RFF 3.16k 1/4W 1%	CGW	12123480A
R625	THR 20 ohm Thermistor	BLI	27500020A
R626	RVC 500 1/4W Pot., 0.5ms GND REF Width Adj.	Amperex	09100350A
R627	RFF 68.1k 1/4W 1%	CGW	12124800A
R628	RFF 12.1k 1/4W 1%	CGW	12124080A
R629	RFF 3.16k 1/4W 1%	CGW	12123480A
R630	RFF 261 1/4W 1%	CGW	12122400A
R631	RFF 100 1/4W 1%	CGW	12122000A
R632	RFF 2.15k 1/4W 1%	CGW	12123320A
R633	RFF 10k 1/4W 1%	CGW	12124000A
R634	RFF 464 1/4W 1%	CGW	12122640A
R635	RFF 10k 1/4W 1%	CGW	12124000A
R801	RFF 46.4k 1/4W 1%	CGW	12124640A
R802	RFF 5.62k 1/4W 1%	CGW	12123720A
R803	RFF 10k 1/4W 1%	CGW	12124000A
R804	RFF 46.4 1/4W 1%	CGW	12124640A
R805	RFF 1k 1/4W 1%	CGW	12123000A
R806	RFC 1M 1/2W 5%	AB	12010100A
R807	RFF 17.8k 1/4W 1%	CGW	12124240A
R808	RFF 10k 1/4W 1%	CGW	12124000A
S601	SWG Pushbutton Switch, Miniature SPNO	BLI	25500180A
L601	LMB Lamp Miniature Amber Lens	BLI	16500030A
L602	LMB Lamp Miniature Green Lens	BLI	16500040A
T601	TRQ 2N3486 PNP	Motorola	10100260A
T602	TRQ 2N2484 NPN	RCA	10100220A
T603	TRQ 2N2484 NPN	RCA	10100220A
T604	TRQ 2N2484 NPN	RCA	10100220A
T605	TRQ 2N2484 NPN	RCA	10100220A
T606	TRQ 2N2484 NPN	RCA	10100220A
T607	TRQ 2N2484 NPN	RCA	10100220A
T701	TRQ 2N2484 NPN	RCA	10100220A
T702	TRQ 2N2192 NPN	Motorola	10100270A
T801	TRQ 2N2484 NPN	RCA	10100260A
T802	TRQ 2N2484 NPN	RCA	10100260A
	TRD Erase Head	BLI	15500000A

TRANSFER CIRCUITS (Figure 11)

SYMBOL	DESCRIPTION	MFR	BLI P/N
C901	CYF 0.1uF 400 V	Sprague	07100770A
C902	CMD 3pF	Erie	07022780A
C903	CYF 22nF	Amperex	07100550A
C904	CYF 0.33uF	Sprague	07100760A
C905	CET 15uF 20 V Tantalum	Sprague	07078150A
C906	CCD 10nF	CRL	07095760A
C907	CYF 1uF	Amperex	07100590A
C908	CYF 1.5nF	Sprague	07100740A
C909	CET 15 uF 20 V Tantalum	Sprague	07078150A
C910	CCD 10nF	CRL	07095760A
C622	CYF 1.5nF	Sprague	07100740A
C623	CYF 1.5nF	Sprague	07100740A
C624	CYF 4.7uF	Amperex	07100590A
C625	CYF 1.5uF	Amperex	07100600A
C626	CYF 0.1uF	Sprague	07100710A
C627	CYF 1uF	Amperex	07100580A
C628	CCD 10nF	CRL	07095760A
C630	CET 15uF 20 V Tantalum	Sprague	07078150A
C631	CYF 10nF	CRL	07095760A
C804	CET 15uF 20 V Tantalum	Sprague	07078150A
C805	CCD 10nF	CRL	07095760A
C807	CYF 1uF	Amperex	07100580A
C808	CYF 0.01uF	Sprague	07100750A
C809	CET 15uF 20 V Tantalum	Sprague	07078150A
C810	CCD 10nF	CRL	07095760A
C811	CYF 0.33uF	Sprague	07100760A
D901	DGP 1N916B/FD600	TI	05079200A
D902	DGP 1N916B/FD600	TI	05079200A
D903	DGP 1N4154/FD600	TI	05079200A
D904	DGP 1N4154/FD600	TI	05079200A
D612	DGP 1N4154/FD600	TI	05079200A
D613	DZP 1N746 Zener Diode	TI	05100170A
D614	DGP 1N4154/FD600	TI	05079200A
D615	DGP 1N4154/FD600	TI	05079200A
R901	RFF 215k 1/4W 1%	CGW	12125320A
R902	RFF 100k 1/4W 1%	CGW	12125000A
R903	RFF 464 1/4W 1%	CGW	12122640A
R904	RVC 500 1/4W Pot., INT Trig Level Adj.	Amperex	09100350A
R905	RFF 383 1/4W 1%	CGW	12122560A
R906	RFF 3.16k 1/4W 1%	CGW	12123480A
R907	RFF 1.47k 1/4W 1%	CGW	12123160A
R908	RFF 1k 1/4W 1%	CGW	12123000A
R909	RFF 90.9k 1/4W 1%	CGW	12124920A
R910	RFC 909k 1/2W 1%	CGW	12125920A

TRANSFER CIRCUITS, Continued (Figure 11)

SYMBOL	DESCRIPTION	MFR	BLI P/N
R911	RFF 383 1/4W 1%	CGW	12122560A
R912	RFF 178 1/4W 1%	CGW	12122240A
R913	RVC 500 1/4W Pot., Transfer Trigger Level Centering	Amperex	09100350A
R914	RFF 2.61k 1/4W 1%	CGW	12123400A
R915	RFF 5.62k 1/4W 1%	CGW	12123720A
R918	RFF 2.15k 1/4W 1%	CGW	12123320A
R919	RVC 100 1/4W Pot., Transfer Trigger Level Concentric with R940	BLI	09500320A
R920	RFF 464 1/4W 1%	CGW	12122640A
R921	RFF 3.83k 1/4W 1%	CGW	12123560A
R922	RFF 3.83k 1/4W 1%	CGW	12123560A
R923	RFF 26.1 1/4W 1%	CGW	12121400A
R924	RFF 26.1 1/4W 1%	CGW	12121400A
R925	RFF 562 1/4W 1%	CGW	12122720A
R926	RFF 10k 1/4W 1%	CGW	12124000A
R927	RFF 121k 1/4W 1%	CGW	12125080A
R928	RFF 3.16k 1/4W 1%	CGW	12123480A
R929	RFF 10k 1/4W 1%	CGW	12124000A
R930	RFF 3.83k 1/4W 1%	CGW	12123560A
R931	RFF 68.1k 1/4W 1%	CGW	12124800A
R933	RFF 121k 1/4W 1%	CGW	12125080A
R934	RFF 316 1/4W 1%	CGW	12122480A
R935	RFF 1.78k 1/4W 1%	CGW	12123240A
R936	RFF 10 1/4W 1%	CGW	12121000A
R937	RFF 10k 1/4W 1%	CGW	12124000A
R938	RFF 5.62k 1/4W 1%	CGW	12123720A
R939	RVC 5k 1/4W Pot., Transfer Delay Limit	Amperex	09100360A
R940	RVC 25k 1/4W Pot., Transfer Delay (Concentric with R919)	BLI	09500320A
R941	RFF 10 1/4W 1%	CGW	12121000A
R636	RFF 5.62k 1/4W 1%	CGW	12123720A
R637	THR 50 ohm Thermistor NTC	BLI	27500010A
R638	RVC 500 1/4W Pot., Marker Adj.	Amperex	09100360A
R639	RFF 5.62k 1/4W 1%	CGW	12123720A
R640	RFF 100 1/4W 1%	CGW	12122000A
R641	RVC 500 1/4W Pot., GND REF	BLI	09500350A
R642	RFF 10k 1/4W 1%	CGW	12124000A
R643	RFF 10 1/4W 1%	CGW	12121000A
R809	RVC 25k 1/4W Pot., Horizontal Position	BLI	09500330A
R810	RFF 10 1/4W 1%	CGW	12121000A
R811	RFF 215 1/4W 1%	CGW	12122320A
R812	RFF 2.15k 1/4W 1%	CGW	12123320A
R813	RFF 1.47k 1/4W 1%	CGW	12123160A
R814	RFF 3.83k 1/4W 1%	CGW	12123560A
R815	RFF 100k 1/4W 1%	CGW	12125000A
R816	RFF 3.16k 1/4W 1%	CGW	12123480A
R817	RFF 10 1/4W 1%	CGW	12121000A
R818	RVC 500k 1/4W Pot., Trigger Delay Limit Adj.	Amperex	09100370A

TRANSFER CIRCUITS, Continued (Figure 11)

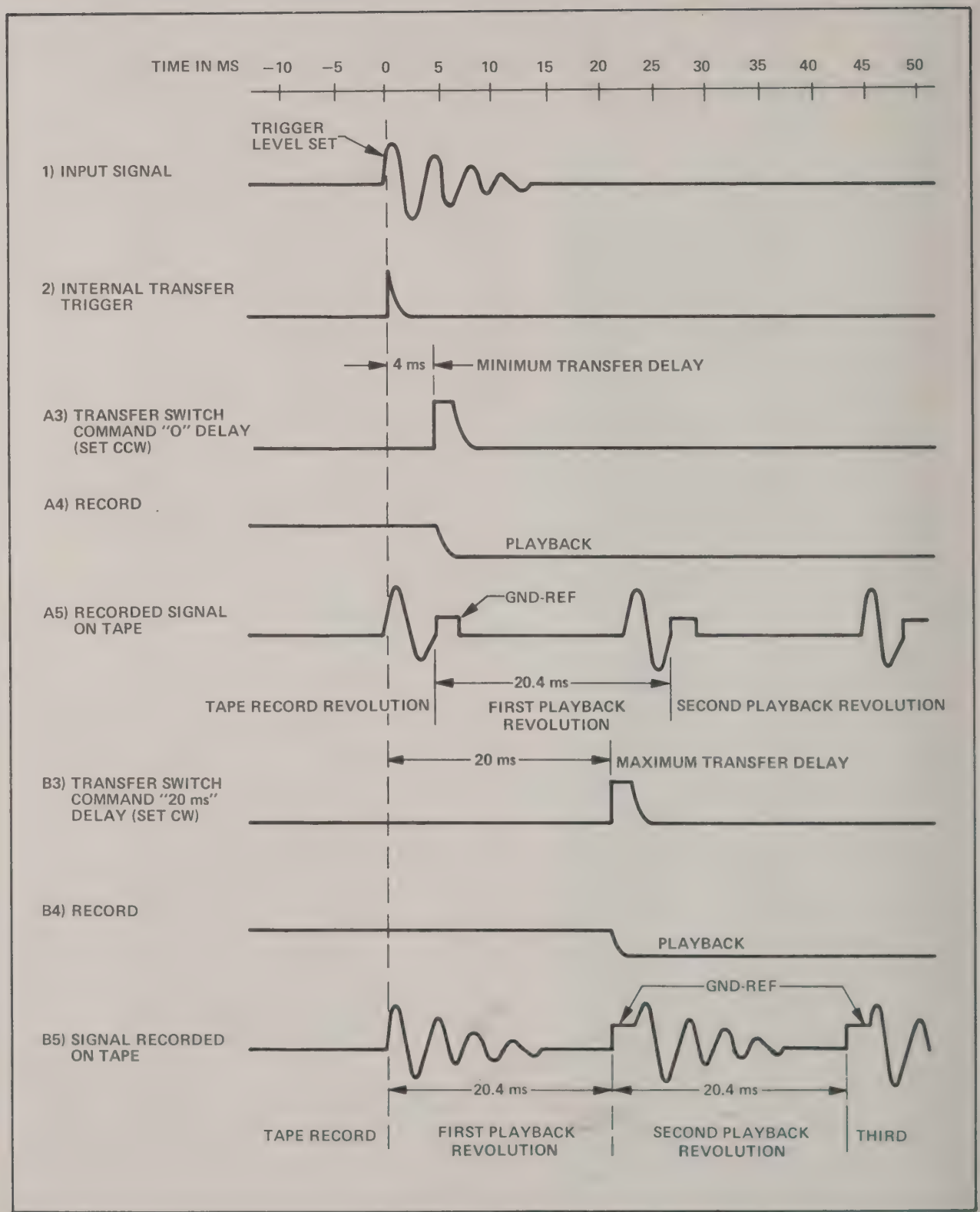
SYMBOL	DESCRIPTION	MFR	BLI P/N
S901	SWG Slide Switch, Minature DP3T, Transfer Source	BLI	25500170A
S902	SWG Slide Switch, Miniature DPDT, Slope	BLI	25500160A
S903	SWG Pushbutton, Momentary, Miniature DPDT Playback Pushbutton	BLI	25500150A
T901	TRQ BF245 FET	TI	10100250A
T902	TRQ 2N3486 PNP	Motorola	10100260A
T903	TRQ 2N2484 NPN	RCA	10100220A
T904	TRQ BF245 FET	TI	10100250A
T905	TRQ 2N3486 PNP	Motorola	10100260A
T906	TRQ 2N2484 NPN	RCA	10100220A
T907	TRQ 2N2484 NPN	RCA	10100220A
T908	TRQ 2N2484 NPN	RCA	10100200A
T909	TRQ 2N2484 NPN	RCA	10100200A
T910	TRQ 2N3486 PNP	Motorola	10100260A
T911	TRQ 2N2484 NPN	RCA	10100220A
T803	TRQ 2N2484 NPN	RCA	10100220A
IC901	ICP 7412	TI	24100090A
IC902	ICP 7400	TI	24094070A
IC604	ICP 7400	TI	24094070A
IC801	ICP 7412	TI	24100090A

POWER SUPPLY AND MOTOR ELECTRONICS (Figure 12)

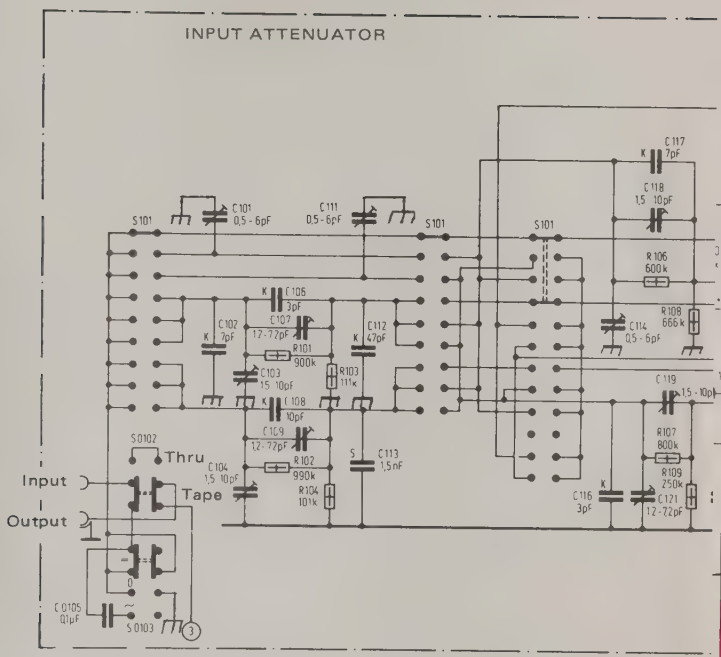
SYMBOL	DESCRIPTION	MFR	BLI P/N
TR201	TRX Power Transformer 115/230 V	BLI	20500040A
C201	CEA 1000uF 25 volts	Mallory	07020700A
C202	CYF 3.3nF	Sprague	07100720A
C203	CYF 2.2nF	Sprague	07100730A
C204	CET 4.7uF 35 V Tantalum	Sprague	07100500A
C206	CYF 0.1uF	Sprague	07100770A
C207	CEA 470uF 25 V	Mallory	07020360A
C208	CET 150uF 6.3 V Tantalum	Sprague	07100520A
C209	CEA 1000uF 25 V	Mallory	07020700A
C211	CET 4.7uF 35 V	Sprague	07100500A
C212	CYF 1.5nF	Sprague	07100740A
C213	CEA 470uF 15 V	Mallory	07020360A
C214	CET 68uF 20 V Tantalum	Sprague	07095660A
C215	CCD 0.001uF 1k	CRL	07095610A
C216	CCD 0.001uF 1k	CRL	07095610A
C301	CET 1 uF 35 V Tantalum	Sprague	07100510A
C302	CYF 0.22uF	Amperex	07100570A
D201	DZG Diode Zener 1N752	TI	05079080A
D202	DRP Diode Bridge MDA 920-A2	Motorola	05094690A
D203	DRP Diode Bridge MDA 920-A2	Motorola	05094690A
IC201	ICP LM305	Natl Semi	24100110A
IC202	ICP LM304	Natl Semi	24100100A
D301	DGP FD600	Fairch	05079200A
D302	DGP FD600	Fairch	05079200A
D303	DGP FD600	Fairch	05079200A
D304	DGP FD600	Fairch	05079200A

POWER SUPPLY AND MOTOR ELECTRONICS, Continued (Figure 12)

SYMBOL	DESCRIPTION	MFR	BLI P/N
	LMB Pilot Lamp, Neon	BLI	16500020A
S201	SWG Power Switch	BLI	25500180A
R200	RFF 383k 1/2W 1%	CGW	12125560A
R201	RFF 68.1 1/4W 1%	CGW	12121800A
R202	RFW 0.56 1/4W 1%	IRC	12126540A
R203	RFF 17.8k 1/4W 1%	CGW	12124240A
R204	RVC 1k 1/4W Pot., +15 V Adj.	Amperex	09100340A
R206	RFF 1.78k 1/4W 1%	CGW	12123240A
R207	RFF 1k 1/4W 1%	CGW	12123000A
R208	RVC 1k 1/4W Pot., −15 V Adj.	Amperex	09100340A
R209	RFF 6.19k 1/4W 1%	CGW	12123760A
R211	RFF 2.15k 1/4W 1%	CGW	1212320A
R212	RFW 0.68 1W 10%	IRC	12126550A
R213	RFF 68.1 1/4W 1%	CGW	12121800A
R214	RFW 1 1W 10%	IRC	12126560A
R215	FLT Surge Suppressor 150 V MOV	GE	14100000A
R301	RFF 150 2W 5%	CGW	12126570A
R302	RFF 150 2W 5%	CGW	12126570A
R303	RFF 3.92k 1/4W 1%	CGW	12123570A
R304	RVC 1k 1/4W Pot., Motor Speed Adj.	Amperex	09100340A
R306	RFF 56.2 1/4W 1%	CGW	12121720A
R307	RFF 825 1/4W 1%	CGW	12122880A
R308	RFF 8.25k 1/4W 1%	CGW	12123880A
	Motor DC Brushless	BLI	29500000A
	Capstan and Flywheel	BLI	75500000A
T201	TRQ 2N5244 NPN	Fairchild	10100280A
T202	TRQ 2N5244 NPN	Fairchild	10100280A
T203	TRQ 2N4400 NPN	Motorola	10100290A
T204	TRQ 2N3055 NPN	RCA	10100310A
T205	TRQ 2N3055 NPN	RCA	10100310A
T301	TRQ 2N4359 PNP	Fairch	10100300A
T302	TRQ 2N4359 PNP	Fairch	10100300A
T303	TRQ 2N4359 PNP	Fairch	10100300A
T304	TRQ 2N4359 PNP	Fairch	10100300A
T305	TRQ 2N3054 NPN	RCA	10079160A
T306	TRQ 2N4359 PNP	Fairch	10100300A
T307	TRQ 2N3054 NPN	RCA	10079160A
T308	TRQ 2N3054 NPN	RCA	10079160A
T309	TRQ 2N3054 NPN	RCA	10079160A
T310	TRQ 2N3054 NPN	RCA	10079160A



ESR TIMING DIAGRAM


INPUT ATTENUATOR
S101
C101 0,5 - 6pF
C111 0,5 - 6pF
C117 7pF
C118 1,5 - 10pF
R106 600k
R108 666k
C114 0,5 - 6pF
C119 1,5 - 10pF
R107 800k
R109 250k
C121 12 - 72pF
C116 3pF
C105 3pF
C107 12 - 72pF
R101 900k
C102 7pF
C103 1,5 - 10pF
R103 111k
C112 47pF
C108 10pF
C109 12 - 72pF
R102 990k
R104 101k
C104 1,5 - 10pF
C113 1,5nF
S0102
Thru
Tape
Input
Output
C0105 0,1µF
S0103

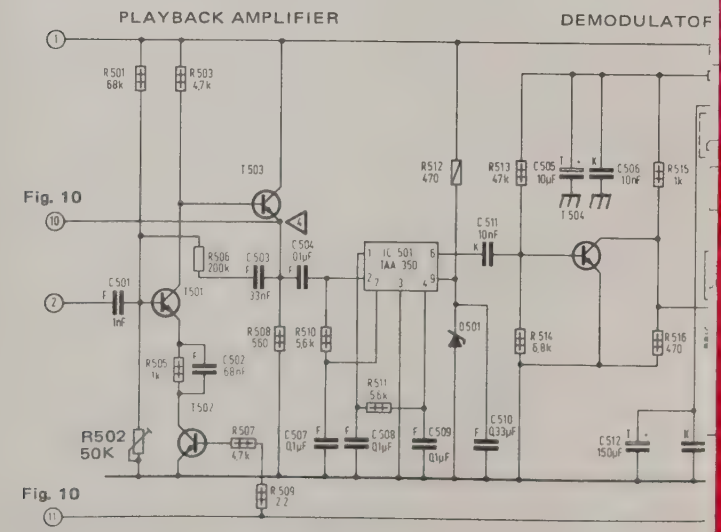
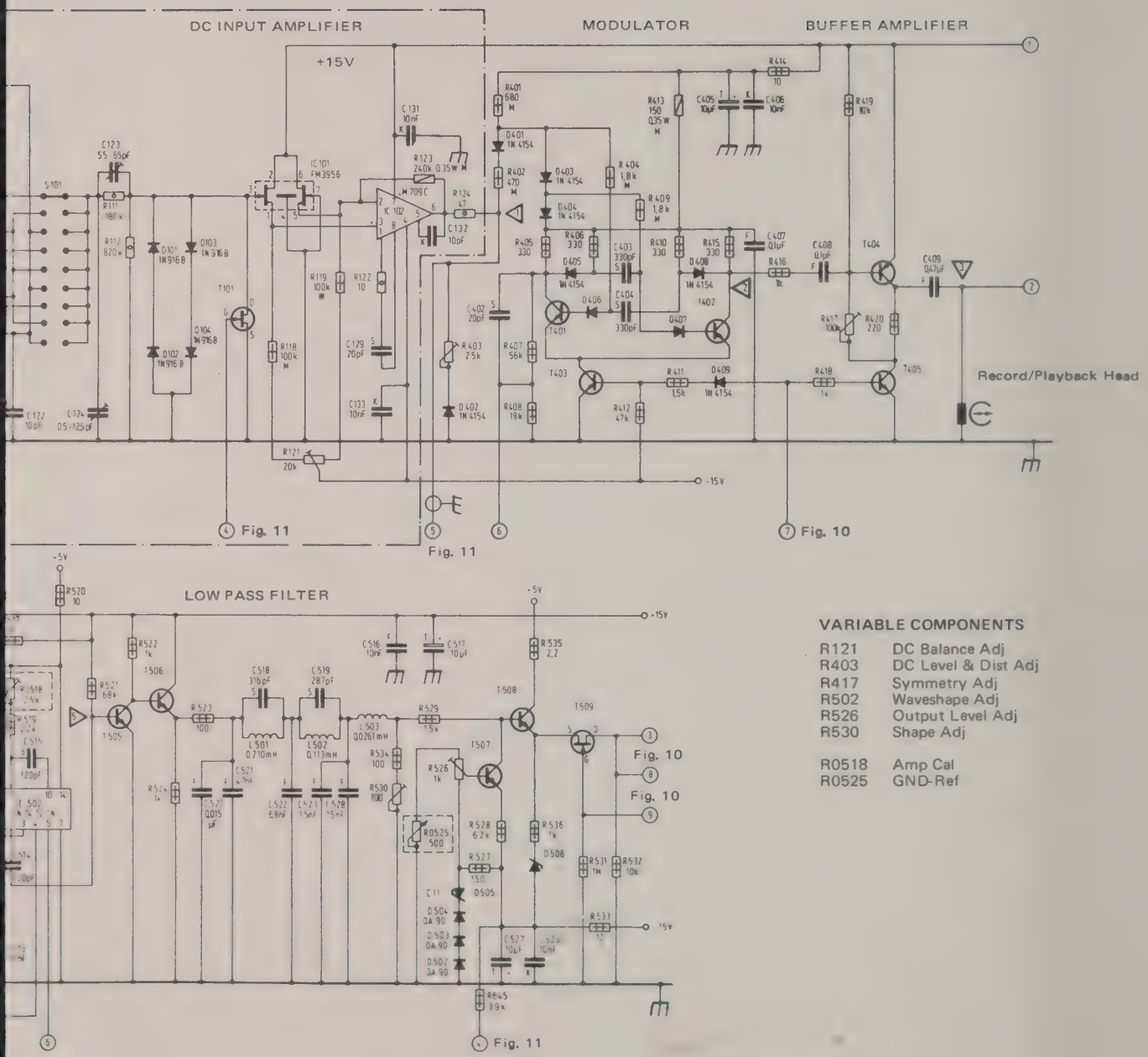

PLAYBACK AMPLIFIER
DEMODULATOR
R501 68k
R503 4,7k
T503
R512 470
R513 47k
C505 10µF
C506 10nF
R515 1k
T504
C511 10nF
R506 200k
C503 33nF
C504 0,1µF
IC 501 TAA 350
C501 1nF
T501
R508 560
R510 5,6k
D501
R514 6,8k
R516 470
R505 1k
C502 68nF
T502
R511 5,6k
R502 50K
R507 4,7k
C507 0,1µF
C508 0,1µF
C509 0,1µF
C510 0,33µF
C512 150µF
R509 2,2

Fig. 10

Fig. 10



VARIABLE COMPONENTS

R121	DC Balance Adj
R403	DC Level & Dist Adj
R417	Symmetry Adj
R502	Waveshape Adj
R526	Output Level Adj
R530	Shape Adj
R0518	Amp Cal
R0525	GND-Ref

Figure 9. Record/Playback Circuits

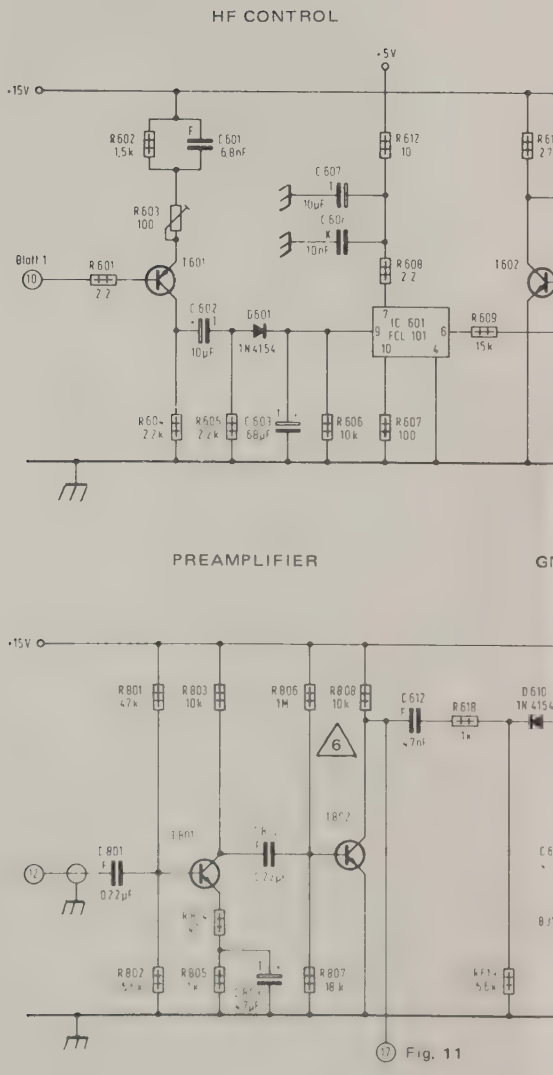
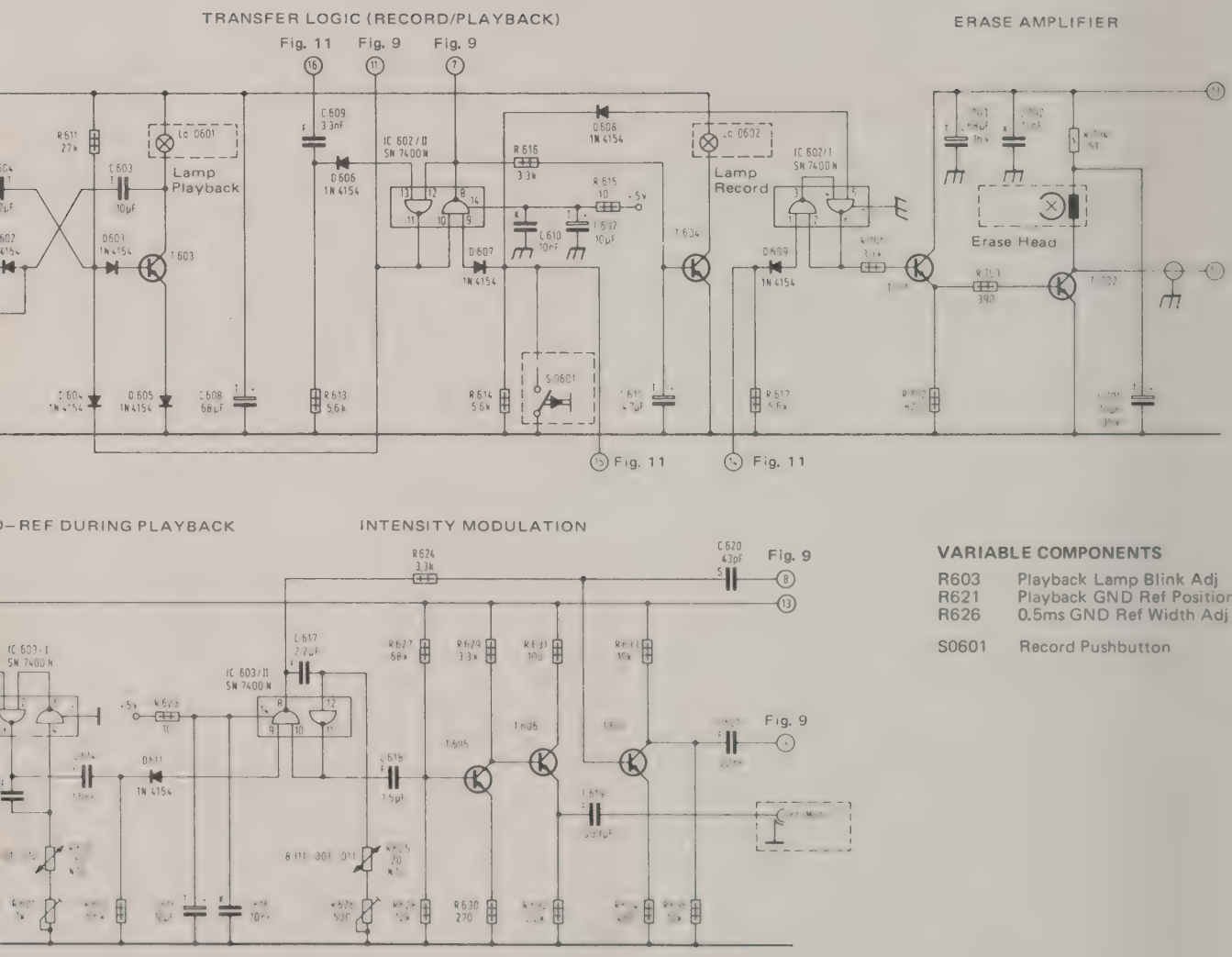

HF CONTROL
+5V
+15V
R602 1,5k
C601 6,8nF
R612 10
C607 10µF
R603 100
C602 10nF
Blatt 1
10
R601 22
T601
R608 22
T602
C602 10µF
D501 1N4154
IC 601 FCL 101
R609 15k
R604 22k
R605 22k
C603 68µF
R606 10k
R607 100
PREAMPLIFIER
+15V
R801 47k
R803 10k
R806 1M
R808 10k
C612
R618 1k
D610 1N 4154
6
T601
T602
C801 0,22µF
R802
R805
R807 18 k
17

Fig. 11



VARIABLE COMPONENTS

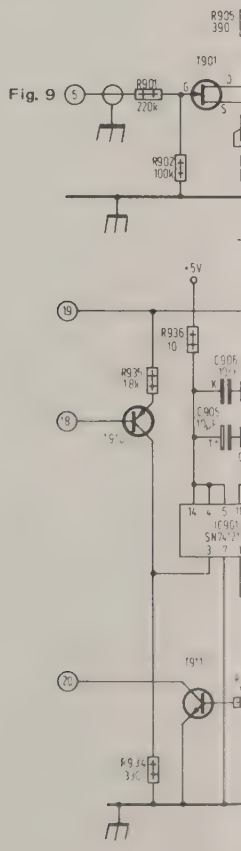
R603	Playback Lamp Blink Adj
R621	Playback GND Ref Position
R626	0.5ms GND Ref Width Adj
S0601	Record Pushbutton

Figure 10. Steering Logic

VARIABLE COMPONENTS

R638	Marker Adj
R641	GND Level Adj
R818	Trigger Delay Limit Adj
R904	Int Trigger Level
R913	Transfer Trigger Level Center
R939	Transfer Delay Limit
R0809	Horiz Position
R0919	Transfer Level
R0940	Transfer Delay
S0902	Slope
S0903	Playback Pushbutton

Fig. 9



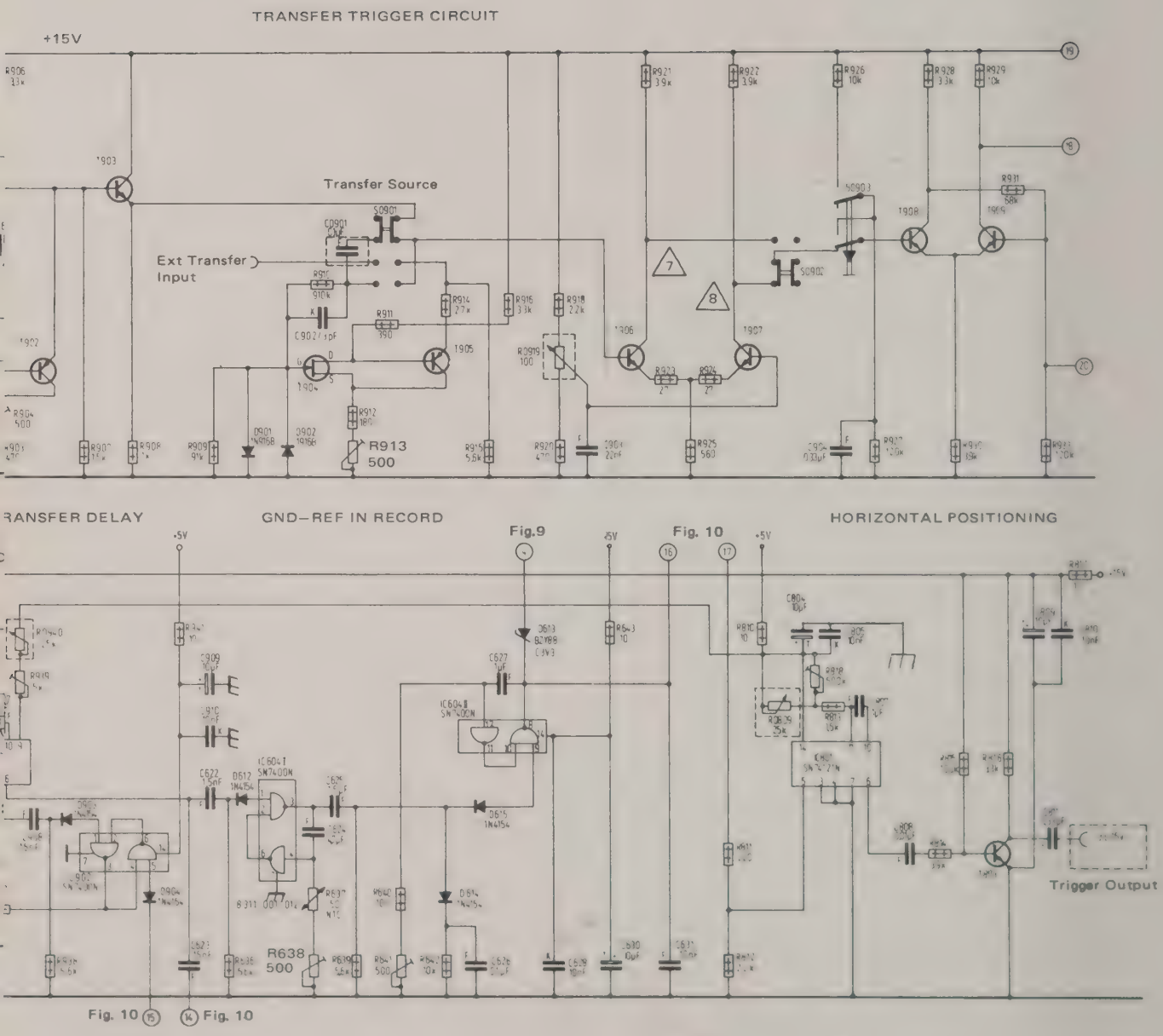
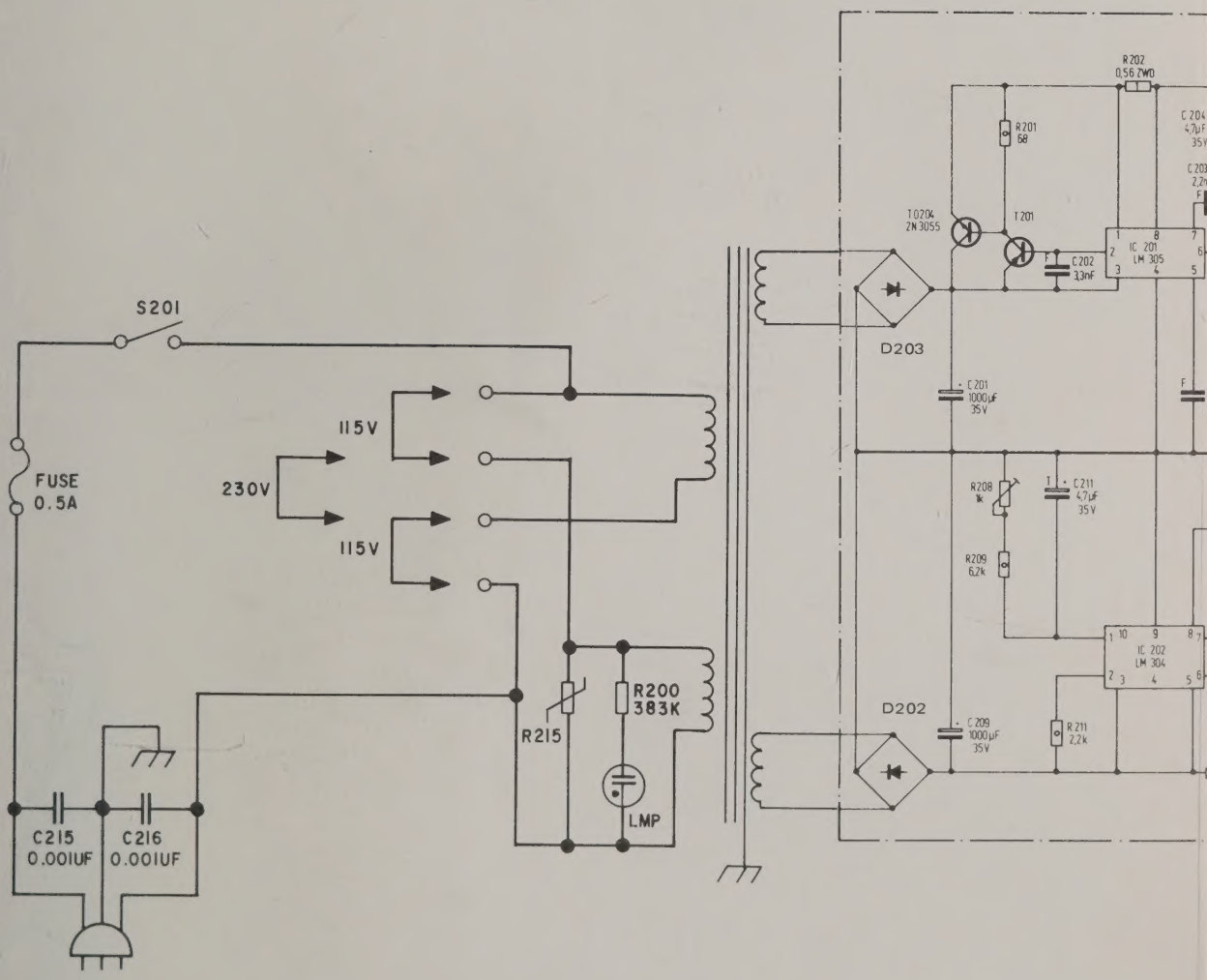
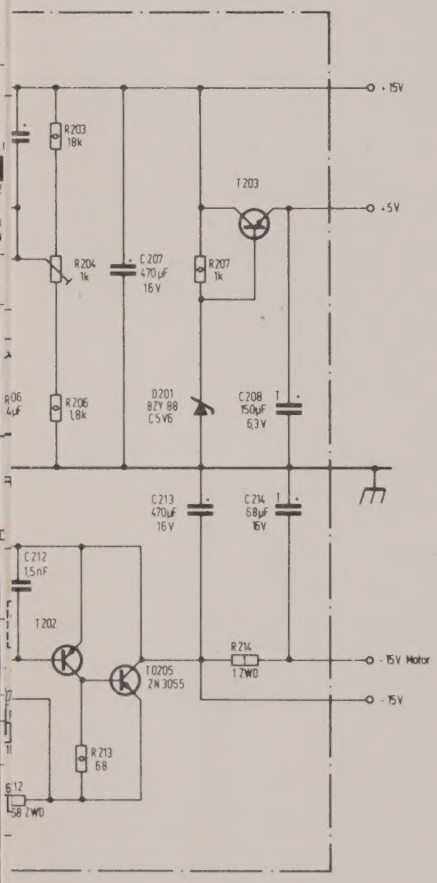


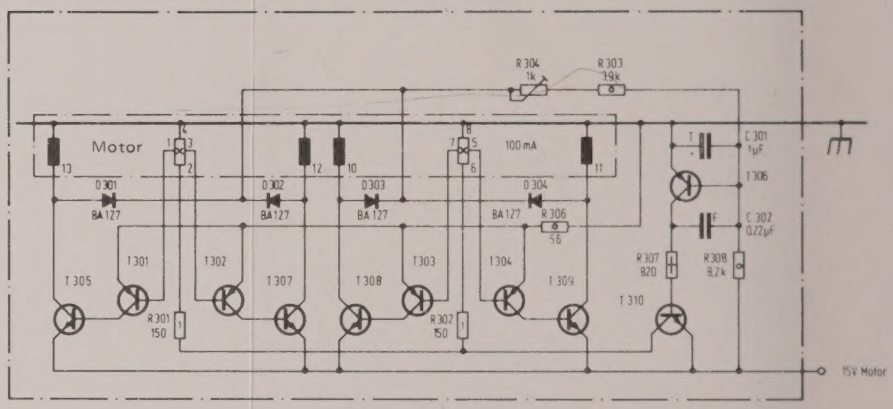
Figure 11. Transfer Circuits


S201
FUSE
0.5A
115V
230V
115V
C215
0.001UF
C216
0.001UF
R215
R200
383K
LMP
D203
D202
R202
0,56 2W0
R201
68
T 0204
ZN 3055
T 201
C 202
3,3nF
IC 201
LM 305
C 201
1000µF
35V
R208
1k
C 211
4,7µF
35V
R209
6,2k
IC 202
LM 304
C 209
1000µF
35V
R 211
2,2k

PLY



MOTOR ELECTRONICS



VARIABLE COMPONENTS

R204	+15V Adj
R208	−15V Adj
R304	Motor Speed Adj

Figure 12. Power Supply & Motor Electronics

MP MASTER
MA31972